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Studies in the North American Convolvulaceae — IV. The genus Exogonium

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(WITH PLATES 1 AND 2)

The genus *Exogonium* is based upon *Ipomoea bracteata* Cav., a Mexican species, and with several other West Indian species forms one of the natural groups of species usually referred to *Ipomoea*. The group is recognized as a genus by Peter and by Hallier, and as a section of *Ipomoea* by Grisebach and by Meissner. *Ipomoea Purga*, which has sometimes been referred to *Exogonium*, appears to be more closely related to a group in *Ipomoea*, of which not all the members possess the salverform corolla and exserted stamens of *I. Purga*, and should more properly be retained in *Ipomoea*. Until very recently the genus was regarded as almost wholly confined to the West Indies. Recent collections in southern Mexico have shown that four species occur in Mexico, one of them apparently identical with *E. argentifolium*, of the West Indies.

EXOGONIUM Choisy, Mém. Soc. Phys. Genèv. 6: 443. 1833. — In DC. Prodr. 9: 346. 1845

Perennial, trailing or twining vines, usually with woody stems. Leaf-blades entire or lobed. Flowers several on axillary peduncles or solitary; bracts large and colored, sometimes inconspicuous or absent. Sepals membranaceous or subherbaceous, equal or unequal, never awned. Corolla scarlet or white; the tube often slender and constricted at the throat or expanding above in a salverform or funnelform limb. Stamens and style exserted or protruding, rarely included. Ovary 2-celled, 4-ovuled. Capsules ovoid, thick-walled, apiculate. Seeds with a long coma of hairs

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on the dorsal angles, rarely pubescent or glabrous. Stigmas capitately 2-lobed.

Type species: *Ipomoea bracteata* Cav.

The species, about 20 in number, are all confined to North America.

Key to the species

A. Inflorescence with conspicuous bracts.
  Bracts ovate-elliptical to linear-lanceolate.
    Inflorescence long-peduncled.
      Bracts 2–3 cm. long.
        Bracts elliptical-obovate, obtuse; sepals obtuse. 1. *E. racemosum.*
        Bracts linear-lanceolate; sepals acuminate. 2. *E. Wrightii.*
      Bracts 1 cm. long, green or tinged with red, subherbaceous. 3. *E. Rudolphii.*
    Inflorescence sessile or nearly so; bracts linear-lanceolate; foliage velvety-pubescent. 4. *E. velutifolium.*
  Bracts reniform-ovate, acute, red; inflorescence spicate. 5. *E. bracteatum.*
B. Inflorescence without conspicuous bracts.
  Leaf-blades silvery-canescent beneath.
    Leaf-blades cordate or subcordate at base.
      Corolla 5 cm. long; leaf-blades silvery beneath, often 3-lobed at the base. 6. *E. jalapoides.*
      Corolla 3 cm. long or less; leaf-blades sericeous beneath, not lobed. 7. *E. fuchsioides.*
    Leaf-blades not cordate; corolla about 3 cm. long.
      Corolla glabrous. Cuban. 8. *E. argentifolium.*
      Corolla pubescent. Mexican. 9. *E. Conzattii.*
  Leaf-blades neither silvery nor sericeous beneath.
    Corolla salverform, scarlet; leaf-blades entire, lobed or 3–5 parted. 10. *E. microdactylum.*
    Corolla-limb not salverform.
      Leaf-blades entire or repand.
        Corolla-limb deeply 5-parted, the lobes lanceolate, acute.
          Corolla golden-yellow. Mexican. 11. *E. luteum.*
          Corolla scarlet. West Indian. 12. *E. repandum.*
        Corolla with 5 short, triangular, scarcely spreading, acute lobes. 13. *E. filiforme.*
      Leaf-blades lobed or 3–9-divided.
        Stems creeping; blades very small.
          Corolla scarlet, constricted above. 14. *E. arenarium.*
          Corolla white, funnelform above. 15. *E. Eggersii.*
        Stems twining or trailing.
          Corolla white; leaf-blades sinuately lobed. 16. *E. cubense.*
          Corolla scarlet; blades divided.
            Sepals equal; leaf-segments obtuse.
              Leaf-segments linear; corolla scarlet. 17. *E. eriospermum.*
              Leaf-segments obovate; corolla greenish; stems minutely pilose. 18. *E. viridiflorum.*
            Sepals unequal.
              Leaf-segments oblong-lanceolate, acuminate. 19. *E. leuconeurum.*
              Leaf-segments narrowly lanceolate, obtuse; corolla-tube slightly inflated. 20. *E. pedatum.*

1. EXOGONIUM RACEMOSUM (Poir.) Choisy, Conv. Rar. 128. 1837. — In DC. Prodr. 9: 346. 1845

Ipomoea racemosa Poir. in Lam. Encyc. Suppl. 4: 633. 1816.
Convolvulus racemosus Spreng. Syst. 1: 600. 1825.
Convolvulus altissimus Spreng. *l. c.* 613.
Ipomoea altissima Bert.; G. Don, Gen. Syst. 4: 273. 1838.

A stout, woody, perennial, branching vine, several m. long, finely pubescent: leaf-blades oblong-ovate, deeply cordate, obtuse, 3–6 cm. long; petioles 1–3 cm. long: peduncles racemosely 2–10-flowered, 6–10 cm. long, each calyx closely subtended by 2–3 elliptical-oblong, obtuse, rose-colored bracts: sepals membranaceous, similar to the bracts: corolla lavender, about 4.5 cm. long, the cylindrical tube slightly constricted above. (PLATE 1, FIGURE *c*.)

TYPE LOCALITY: St. Domingo.

DISTRIBUTION: St. Domingo and Hayti. Reported from Cuba.

SPECIMENS EXAMINED: Hayti, La Brande to Mt. Balance, *Nash & Taylor 1696*, 1905.

2. **Exogonium Wrightii** sp. nov.

Ipomoea racemosa Griseb. Cat. Pl. Cub. 205. 1866. Not *I. racemosa* Poir. 1816.

A stout, woody, perennial, twining vine: stems appressed-pubescent above: leaf-blades ovate, obtuse, deeply cordate, 5–8 cm. long, glabrate above, densely appressed-pubescent beneath, strongly reticulate-veined: peduncles elongated, often terminating branches and leafy, 10–20 cm. long, several-flowered; pedicels filiform, 2–4 cm. long; bracts linear-lanceolate, 1.5–2 cm. long, pubescent: sepals lanceolate, acuminate, appressed-pubescent below, 18–22 mm. long: corolla reddish-purple, salverform, 4 cm. long, the limb as broad: stamens and style exserted 6–10 mm. (PLATE 1, FIGURE *d*.)

CUBA: "N. Sophie [Isle of Pines], climbing to tops of tall trees," *C. Wright 1650*, 1859–1860. (Type in the Gray Herbarium.)

3. **Exogonium Rudolphii** (Roem. & Schult.)

Ipomoea bracteata Rudol.; Ledeb. in Schrad. Neues Jour. Bot. 2: 292. 1807. Not *I. bracteata* Cav. 1799.
Ipomoea Rudolphii Roem. & Schult. Syst. 4: 222. 1819.
Pharbitis bracteata Choisy in DC. Prodr. 9: 344. 1845.
Rivea bracteata Hallier f. Bot. Jahrb. 18: 158. 1894.

Resembling the preceding: stems retrorsely strigose-pubescent: leaf-blades deltoid-ovate, cordate, entire or somewhat 3-lobed, glabrous above, pubescent beneath: peduncles 1- or loosely few-flowered; bracts ovate, obtuse: sepals herbaceous, similar to the bracts but smaller, sometimes acute, 1 cm. long or less: corolla subsalverform, scarlet, 3–4 cm. long; limb 2.5–3 cm. broad: stamens and style exserted. (PLATE I, FIGURE *a*.)

TYPE LOCALITY: St. Domingo.

DISTRIBUTION: St. Domingo and Cuba.

SPECIMENS EXAMINED: Cuba, *C. Wright 3096* (in herb. Gray).

4. **Exogonium velutifolium** sp. nov.

A slender, woody, high-climbing, irregular vine: Stems velvety-pubescent above: leaf-blades oblong-ovate, obtuse, rounded at the base, entire or irregularly crenate-lobed toward the base, 6–30 mm. long, velvety-pubescent; petioles 2–5 mm. long: flowers 2 or 3 together, sessile or nearly so near the ends of the branches; bracts and sepals linear-lanceolate: sepals subequal, acuminate, 7–8 mm. long, tomentose: corolla crimson, glabrous, 3 cm. long or less, slightly constricted at the throat, the slightly spreading limb with 5 rounded lobes, 5–6 mm. long and as broad: stamens and style protruding. (PLATE I, FIGURE *b*.)

MEXICO: Oaxaca, west side of the valley of Cuicatlan, 2000–4000 ft. alt., *E. W. Nelson 1887*, Nov. 9, 1894 (type in herb. Gray; dupl. in Nat. Herb.).

5. EXOGONIUM BRACTEATUM (Cav.) Choisy; G. Don, Gen. Syst. **4**: 264. 1838

Ipomoea bracteata Cav. Ic. **5**: 51. *pl. 447*. 1799.

Ipomoea spicata H. B. K. Nov. Gen. et Sp. **3**: 112. 1819.

Ipomoea cincta Roem. & Schult. Syst. **4**: 254. 1819.

Convolvulus obvallatus Spreng. Syst. **1**: 595. 1825.

Exogonium spicatum Choisy, Conv. Rar. 128. 1837. — In DC. Prodr. **9**: 347. 1845.

Exogonium Olivae Bárcena, Viaje Cav. Cacahuam. 29. 1874.

Convolvulus bractiflorus Sessé & Moc. Pl. Nov. Hisp. 23. 1887.

TYPE LOCALITY: Near Mazatlan, Mexico.

DISTRIBUTION: Lower California and western Mexico to Central America.

SPECIMENS EXAMINED: Sonora, *Palmer 313*, 1890, *10*, 1890; Sinaloa, *W. G. Wright 1258*, 1899, *Palmer 1787*, 1891, *Lamb 450*,

1895; Morelos, *Bilimek 99*, 1866, *Pringle 8012*, 1899; Chihuahua, *Palmer 294*, *296*, 1885.

Exogonium bracteatum pubescens (Rob. & Greenm.)

Ipomoea bracteata var. *pubescens* Rob. & Greenm. Am. Jour. Sci. **50**: 160. 1895.

MEXICO: Jalisco, Barranca near Guadalajara, *Pringle 4734*, 1894.

6. **Exogonium jalapoides** (Griseb.)

Ipomoea jalapoides Griseb. Cat. Pl. Cub. 202. 1866.

Stems woody below, densely pubescent: leaf-blades oblong-lanceolate, entire, 3–5 cm. long, or 3-lobed at the base, the middle lobe lanceolate, 4-5 cm. long, lateral lobes oblique, 2 cm. long or less, densely appressed-pubescent above: peduncles 1–3-flowered: sepals oblong, obtuse, 7–9 mm. long, densely tomentose without: corolla scarlet, the limb fully 4 cm. broad.

TYPE LOCALITY: Cuba.

DISTRIBUTION: Cuba.

SPECIMENS EXAMINED: *C. Wright 3097* (co-type in herb. Columbia Univ.).

7. **Exogonium fuchsioides** (Griseb.)

Ipomoea fuchsioides Griseb. Cat. Pl. Cub. 205. 1866.

Stems finely appressed-pubescent: leaf-blades narrowly ovate-lanceolate, acuminate, rounded or subcordate at the base, green and appressed-pubescent above, pale and sericeous-pubescent beneath, 2–4 cm. long, sometimes 5–7 cm. long, obtuse, 3–4 cm. wide and obtusely auricled at the base: pedicels and calyx glabrous: sepals unequal, 5–6 mm. long, obtuse, tinged with red: corolla-tube 3 cm. long, 4–5 mm. in diameter; limb crimson, 1.5–2 cm. broad with 5 rounded lobes.

TYPE LOCALITY: Cuba, "Bahia Honda".

DISTRIBUTION: Cuba.

SPECIMENS EXAMINED: *C. Wright 3095* (in herb. Gray). The co-type in the Gray Herbarium is mixed with the entire-leaved form of *E. microdactylum*, which perhaps accounts for the mistaken identification of the latter in most herbaria as "*Ipomoea fuchsioides*." The variety *parvifolia* Griseb. *l. c.* appears to be but a small leaf-form, while the variety *glabra* belongs to the entire-leafed variety of *E. microdactylum*.

8. **Exogonium argentifolium** (A. Rich.)

Ipomoea? argentifolia A. Rich. in Sagra, Hist. Fis. Cuba **11**: 131. 1850.

Ipomoea praecox Wright [in Sauv. Fl. Cub. 107] Anal. Acad. Habana **7**: 46. 1870.

A stout twining vine: stems tomentose above: leaf-blades oblong-lanceolate to elliptical-oblong, acute or rounded at the base, the apex acute or obtuse, 2–10 cm. long, woolly above, becoming glabrate: sepals suborbicular, obtuse, 5–6 mm. long, woolly or tomentose without, equal: corolla salverform, the tube 6–7 mm. in diameter; the limb 3 cm. broad.

TYPE LOCALITY: "Prope Nouvelle Sophie," Isle of Pines.

DISTRIBUTION: Cuba, Isle of Pines, and southern Mexico.

SPECIMENS EXAMINED: Cuba, *C. Wright 449, 3646; Cook*, 1905. Isle of Pines, *Curtiss 489*, 1904, *Rowlee 182*, 1901. Mexico: Oaxaca, *Conzatti & Gonzalez 332*, 1894, *Pringle 5636*, 1894: Puebla, *E. W. Nelson 2009*, 1895, *Pringle 7016*, 1895.

9. **Exogonium Conzattii** (Greenm.)

Ipomoea Conzattii Greenm. Field. Col. Mus. Publ. Bot. **2**: 258. 1907.

Resembling the preceding: leaf-blades not seen: flowers in dense, many-flowered, subsessile clusters; pedicels and peduncles tomentose: sepals slightly unequal, broadly ovate, obtuse, tinged with red: corolla-tube 3 cm. long, the scarlet limb 2 cm. broad, pubescent without: capsules 10–12 mm. in diameter, 2-celled; coma of hairs on the seeds white.

TYPE LOCALITY: Almoloyas, Guerrero, Mexico.

DISTRIBUTION: Southern Mexico.

SPECIMENS EXAMINED: Guerrero, *E. W. Nelson 2095*, 1894 (in herb. Gray and Nat. Herb.). (The type, *Conzatti 1666*, 1906, in herb. Field Mus., not seen.)

10. **Exogonium microdactylum** (Griseb.)

Ipomoea microdactyla Griseb. Cat. Pl. Cub. 204. 1866.

A glabrous twining vine: stems woody below, striated or muricate: leaf-blades 3–5-lobed or subentire, 3–6 cm. long, thick-textured, lobes usually oblanceolate, obtuse, reticulate-veined: peduncles 1–3-flowered: sepals unequal, orbicular-ovate, obtuse, 5–7 mm. long: corolla scarlet, subsalverform, 3–4 cm. long, the limb 3–5 cm. broad and slightly 5-lobed: capsules 10 mm. in diameter, ovoid, apiculate.

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TYPE LOCALITY: Cuba.

DISTRIBUTION: Cuba and the Bahamas.

SPECIMENS EXAMINED: Cuba, *C. Wright 3094* (co-type in herb. Columbia Univ.), *Britton, Britton, & Shafer 735*, 1903; Bahamas, Andros, *Northrop 394*, 1890, *Brace 6756*, 1907; Great Exuma, *Britton & Millspaugh 2923*, 1905; Eleuthera, *Britton & Millspaugh 5594*, 1905; Conception Island, *Britton & Millspaugh 6029*, 1907; Long Cay, *Brace 4010, 4173*, 1905; Acklin's Island, *Brace 4280*, 1906; New Providence, *Curtiss 211*, 1903.

Exogonium microdactylum integrifolium var. nov.

Ipomoea repanda Griseb. *l. c.* 204. Not *I. repanda* Jacq. 1760.

Leaf-blades nearly or quite entire, oblong-ovate, subcordate, truncate or sometimes obtuse at the base.

CUBA: *C. Wright 3102* (co-type in herb. Columbia Univ.), *Cook 46*, 1906, *Combs 607*, 1895, *Baker 2171*, 1904. BAHAMAS: New Providence, *Britton & Millspaugh 2105*, 1905, *Britton & Brace 800*, 1904; Crooked Island, *Brace 4627, 4739*, 1906; Rum Cay, *Brace 3982*, 1905; Berry Islands, *Britton & Millspaugh 2336*, 1905; Inagua, *Nash & Taylor 1258, 1310*, 1904; Andros, *Brace 6988*, 1907; Great Bahama, *Brace 3569, 3701*, 1905; Abaco, *Brace 1593*, 1904. Watling's Island, *Wilson 7212*, 1907; North Caicos, *Wilson 7716*, 1907; Mariguana, *Wilson 7521*, 1907. FLORIDA: Pinelands near Cutler, *Small & Carter 788, 816*, 1903. Long Key, *Small & Wilson 1971*, 1903.

11. **Exogonium luteum** sp. nov.

A stout, woody, twining vine, minutely pubescent: leaf-blades triangular-ovate, acuminate, 5–8 cm. long, minutely but densely pubescent above, velvety-pubescent beneath; petioles short: peduncles 5–10 cm. long, tomentose, cymosely many-flowered; pedicels 1.5–3 cm. long: sepals slightly unequal, ovate, obtuse, glabrous or the outer tomentose, 4–6 mm. long: corolla 3–5 cm. long, golden-yellow, the straight tube 5 mm. in diameter, the spreading limb divided to the top of the tube into 5 lanceolate, acute lobes about 15 mm. long, each with a small tuft of white hairs at the tip: stamens and style long-exserted; the sagittate anthers 3.5 mm. long. (PLATE 2, FIGURE *c.*)

MEXICO: Oaxaca, Cuesta de Chiquihuetlan, 3300 ft. alt., *Conzatti & Gonzalez 668*, Sept. 2, 1895 (type in herb. Gray).

12. EXOGONIUM REPANDUM (Jacq.) Choisy, Conv. Rar. 128. 1837. — In DC. Prodr. **9**: 347. 1845

Ipomoea repanda Jacq. Pl. Carib. 13. 1760. — Select. Stirp. Amer. 28. *pl. 20.* 1763. — L. Sp. Pl. ed. 2, 1668. 1763.

Convolvulus repandus Desr. in Lam. Encyc. **3**: 555. 1789.

TYPE LOCALITY: St. Francis, Martinique.

DISTRIBUTION: In thickets, Porto Rico and the Lesser Antilles.

SPECIMENS EXAMINED: Porto Rico, *Sintenis 5330*, 1886; Martinique, *Duss 1890*, 1880; Guadeloupe, *Duss 2478*, 1892; Grenada, *Broadway*, 1905; Montserrat, *Shafer 401*, 1907.

13. EXOGONIUM FILIFORME (Jacq.) Choisy, Conv. Rar. 127. 1837. — In DC. Prodr. **9**: 347. 1845

Ipomoea filiformis Jacq. Pl. Carib. 13. 1760. — Select. Stirp. Amer. 27. *pl. 19.* 1763.

Convolvulus filiformis Desr. in Lam. Encyc. **3**: 555. 1789.

TYPE LOCALITY: Martinique.

DISTRIBUTION: In thickets, Porto Rico and the Lesser Antilles.

SPECIMENS EXAMINED: Porto Rico, *Heller*, 1902; Martinique, *Duss 425*, 1879; Guadeloupe, *Madiana 23*, 1872, *Duss 3085*, 1893; St. Thomas, *Eggers 48*, 1887; St. Croix, *Ricksecker 39*, 1895.

14. EXOGONIUM ARENARIUM Choisy, Conv. Rar. 129. *pl. 1.* 1837. — In DC. Prodr. **9**: 347. 1845

Ipomoea arenaria Steud. Nom. ed. 2. 815. 1841. Not *I. arenaria* Roem. & Schult. 1819.

Ipomoea Steudeli Millsp. Field. Col. Mus. Publ. Bot. **2**: 86. 1901.

TYPE LOCALITY: Caribbean Islands.

DISTRIBUTION: Littoral, Porto Rico and the Lesser Antilles.

SPECIMENS EXAMINED: Porto Rico: *Underwood & Griggs 544, 547*, 1901, *Sintenis 3457*, 1888, *Heller 6170*, 1902; Culebra, *Britton & Wheeler 30*, 1906. (PLATE 2, FIGURE *d*.)

15. **Exogonium Eggersii** sp. nov.

A perennial, slender, trailing vine, exactly simulating the preceding: leaf-blades 3–12 mm. long, nearly as broad, obcordate or notched at the apex, the base truncate or hastately lobed: peduncles 6–8 mm. long, 1-flowered: sepals equal, orbicular-ovate,

glabrous, 5–6 mm. long, rounded: corolla white, funnelform, expanding from the base upward, 3.5–4 cm. long, the limb 3–3.5 cm. broad with 5 slightly rounded lobes: capsules ovoid, exceeding the calyx; seeds lanate on the dorsal angles. (PLATE 2, FIGURE *a*.)

ST. THOMAS: *Eggers*, Feb. 1887 (type in herb. N. Y. Bot. Garden), January 14 and March 24, 1876; *266*, 1880 (in herb. Gray).

16. **Exogonium cubense** sp. nov.

A slender, perennial, twining vine, several m. high: stems woody below: leaf-blades ovate, or ovate-lanceolate, 3–8 cm. long, obtuse or subcordate at the base, entire or sinuately 3–5-lobed, middle lobe largest, lateral ones oblique and half as long; petioles shorter than the blades: peduncles 2–5 cm. long, 2–5-flowered; pedicels 10–15 mm. long: sepals unequal, the inner larger, ovate, obtuse, 8–10 mm. long and nearly as broad, the outer 5–6 mm. long: corolla white, about 5 cm. long, the tube 2–2.5 cm. long, thicker within the calyx than above, where it begins to expand into a funnelform or subsalverform limb 4–5 cm. broad and 5-lobed, the externally green plaits of the corolla ending in minute cusps at the margin. (PLATE 2, FIGURE *b*.)

CUBA: Gorge of the Yumuri, Matanzas, *Britton & Shafer 495*, March 20, 1903 (type in herb. N. Y. Bot. Garden).

This might be the *Ipomoea alterniflora* Griseb. as to all parts except the corolla, which is described as being purple, and an unnumbered specimen of Wright's so labeled in the Gray Herbarium is identical with *E. cubense*. All material of Wright's, other than this, labeled *I. alterniflora*, is *Ipomoea obtusata* Griseb. and it is evident that either the corolla was wrongly described in *I. alterniflora*, or what is more likely, considering the mixture of species under some of Wright's numbers, that the description of *I. alterniflora* represents two species, viz. *E. cubense* in part and *Ipomoea obtusata* as to the flowers.

17. EXOGONIUM ERIOSPERMUM (Desr.) Choisy, Conv. Rar. 130. 1837.—In DC. Prodr. **9**: 347. 1845

Convolvulus eriospermus Desr. in Lam. Encyc. **3**: 567. 1789.
Ipomoea eriosperma Raf. Fl. Tellur. **4**: 74. 1838. — Urb. Symb. Ant. **3**: 350. 1902. Not *I. eriosperma* Beauv. 1807.
Ipomoea Desrousseauxii Steud. Nom. ed. 2. 816. 1841.

TYPE LOCALITY: St. Domingo.

DISTRIBUTION: St. Domingo.

SPECIMENS EXAMINED: *Wright, Parry, & Brummel 378*, 1871 (in Nat. Herb.).

18. **Exogonium viridiflorum** (Urb.)

Ipomoea viridiflora Urb. Symb. Ant. **3**: 348. 1902.

Stems dark-red, striate, minutely pilose above: leaf-blades pedately divided, middle lobe 3–4 cm. long, 1.5–2.5 cm. broad; petioles 2–3 mm. long: peduncles 1–2 cm. long, 1–few-flowered: sepals obovate-orbicular, 6 mm. long, the inner ones emarginate.

TYPE LOCALITY: Hayti.

DISTRIBUTION: Hayti.

19. **Exogonium leuconeurum** (Urb.)

Ipomoea leuconeura Urb. Symb. Ant. **3**: 350. 1902.

Prostrate or trailing: stems woody below, striate: leaf-blades digitately 7- (rarely 5- or 6-) divided, segments 5–30 mm. long, attenuate below into petiolules 3 mm. long: peduncles 2-7 mm. long, 1–10-flowered; pedicels 7–12 mm. long: sepals green or tinged with red, unequal, outer 3.5 mm. long, inner narrowly ovate or obovate, 5 mm. long, rounded or emarginate: corolla scarlet, 35–45 mm. long, slightly inflated in the middle, the limb about 25 mm. broad: capsules oblong, 15 mm. high; seeds with a yellowish white coma of long reflexed hairs.

TYPE LOCALITY: Hayti.

DISTRIBUTION: Hayti. No specimens seen.

20. EXOGONIUM PEDATUM Choisy, Conv. Rar. 130. 1837. — In DC. Prodr. **9**: 347. 1845

Stems woody below, terete: leaf-blades pedate, lateral lobes 2-parted; segments petiolulate, narrowly lanceolate, obtuse, 1.5–3 cm. long, 4–7 mm. wide or less: peduncles 2–5 cm. long, 2–6-flowered: outer sepals slightly shorter than the inner, which are about 4 mm. long, oval: corolla red, 3.5–4.5 cm. long.

TYPE LOCALITY: St. Domingo.

DISTRIBUTION: Hayti and St. Domingo.

SPECIES INQUIRENDAE

IPOMOEA RUBROCINCTA Urb. *l. c.* 347. Doubtfully distinct from *E. pedatum*, from the description, although no specimens have been seen.

IPOMOEA NEMATOLOBA Urb. *l. c.* 349. Stems plicate-striate: leaf-blades digitately divided into 5–7, obtuse, filiform segments, 35 mm. long by 0.5 mm. wide; petioles 3–9 mm. long: peduncles 1–3 mm. long: outer sepals oval, 3 mm. long, inner ones 3.5 mm. long, rounded at the apex: corolla white, tinged with green, the oval, subemarginate lobes of the limb 9–10 mm. long. Hayti.

NEW YORK BOTANICAL GARDEN.

The New England species of Closterium

Joseph Augustine Cushman

With the exception of the very large genera *Cosmarium* and *Staurastrum*, the genus *Closterium* is usually the most noticeable in number of species and individuals of any genus of desmids. Oftentimes pure collections may be obtained of certain species in ditches or small pools. The genus is an interesting one in showing the many changes that may take place in a simple form without a complication of lobes and about a single axis.

In its generalized form *Closterium* consists of an arcuate cell tapering from the middle toward the ends and generally circular in cross-section. Upon this simple plan of structure all the various differences in shape, size, and ornamentation take place. All gradations exist between species in which the axis is a straight line to those in which it forms a semicircle. The cell-wall may be colorless or in older specimens various shades of yellowish or reddish-brown. The surface may be smooth or have delicate striations, costae, or even longitudinal markings made up of a series of granules arranged in a longitudinal manner. The apices of the cell form one of the constant features in the species. In the genus they range from squarely truncate to the finest of acute points or even may be larger than the adjacent portions of the cell. In a few of the species the ends of the cell are drawn out into long colorless setaceous beaks.

There are two distinct groups of *Closterium*, according to the manner of division. In one, the cell divides in the middle and the new halves are of the usual size, the new cells being of practically the same length as the first. In another group, division may take place and then be followed by an elongation of the old cell by the insertion of a median section between the original semi-cells. The limits of this are shown by distinct transverse lines across the cell, each suture really representing a cell division.

The semi-cells each contain a single chloroplast, with longitudinal ridges in most cases; at the distal end of the chloroplast is a

vacuole containing one or more crystals of calcium sulphate in continuous motion. Since the desmids were first known, these granules have been a point of interest.

The zygospores of *Closterium* are usually formed between the parent cells and are free. In certain cases the zygospores are paired but usually single and globose. As a rule the zygospores are smooth but in a few species there are spines. In a few species cruciform or quadrate zygospores are formed and the cells remain attached for some time.

Enough synonymy is given under each species to refer to published figures in accessible works and to straighten out many of the New England records already published. The figures given are camera-lucida drawings from specimens. The figures given by Wolle were in many cases rather too conventionalized to represent clearly the form he had under observation. In all, about fifty species of this genus are now known from New England. Those not previously recorded are indicated by an asterisk. The measurements and short description are based entirely upon observed specimens from New England.

As given here, length means the length of a straight line drawn between the apices — not the length of the axis of the cell. Breadth means the diameter across the middle of the cell; where the cross-section of the cell is elliptical, as it is in some of the straight forms, the greatest diameter is given. Records for which I have seen specimens are followed by an exclamation point. In other cases the author's name is given in parentheses.

It will be noted that many of the species are recorded only from southeastern Massachusetts and Rhode Island. Collections from this region were especially rich in *Closterium*, both in number of species and individuals.

1. CLOSTERIUM CYNTHIA DeNot.

Closterium Cynthia DeNot. Elem. Stud. Desm. Ital. 65, *pl. 7. f. 71.* 1867. — Johnson, Bull. Torrey Club **22**: 291. *pl. 239. f. 3.* 1895. — W. & G. S. West, Brit. Desm. **1**: 113. *pl. 11. f. 1–3.* 1904.

Cells small, about 8–10 times as long as wide, strongly curved, apices obtusely rounded; cell-wall yellow-brown with about 13–16 striae visible across the cell.

Length 140–170 μ; breadth 15.5–19 μ; apices 3.5–4 μ; diameter of zygospore 40–46 μ. (PLATE 3, FIGURES 1, 2.)

NEW HAMPSHIRE: North Woodstock!

MASSACHUSETTS: Reading, with zygospores! Lake Watuppa, Fall River!

*2. CLOSTERIUM MALMEI Borge

Closterium Malmei Borge, Arkiv för Botanik 1: 79. *pl. 1. f. 21.* 1903.

Cells of medium size, about six times as long as wide, strongly curved, outer margin an arc of 140°, inner margin not tumid but evenly curved throughout, gradually narrowed to the apices, which are slightly dilated, then suddenly attenuated; cell-wall reddish-brown in color, with about 10–12 costae visible across the cell.

Length 250–405 μ; breadth 50–63 μ; apex 11–15.5 μ. (PLATE 3, FIGURES 4, 5.)

MASSACHUSETTS: East Bridgewater! Chilmark (H. C., *no. 663*)!

Our specimens seem to be identical with those of Borge, described from Paraguay as *C. Malmei.*

*3. CLOSTERIUM ARCHERIANUM Cleve

Closterium Archerianum Cleve, in Lund. Nova Acta Reg. Soc. Sci. Upsal. III. 8: 77. *pl. 5. f. 13.* 1871.—W. & G. S. West, Brit. Desm. 1: 115. *pl. 11. f. 8–10.* 1904.

Cells of medium size, about ten times as long as wide, strongly curved, narrowing regularly to the apices; cell-wall brown with 8–10 striae visible across the cell.

Length 185–210 μ; breadth 19–22 μ. (PLATE 3, FIGURE 3.)

MASSACHUSETTS: Reading!

4. CLOSTERIUM DIDYMOTOCUM Corda

Closterium didymotocum Corda, Alm. de Carlsbad, 185, 190, 192, 209. *pl. 5. f. 64, 65.* 1835.—Wolle, Desm. U. S. 39. *pl. 8. f. 12, 13.* 1884.—Johnson, Bull. Torrey Club 21: 286. 1894.—W. & G. S. West, Brit. Desm. 1: 116. *pl. 12. f. 1–5.* 1904.

Closterium Ensis Cushman, Rhodora 5: 255. 1903.

Cells large, 9–12 times as long as wide, slightly curved, apices broad, truncated, angles rounded, often slightly recurved; cell-wall yellow-brown, ends with a darker annular thickening, smooth or often delicately striate.

Length 310–560 μ; breadth 25–56 μ; apices 12.5–18.6 μ. (PLATE 3, FIGURE 16; PLATE 5, FIGURE 6.)

MAINE: Orono (*W. West*); Kittery! Mud Pond, Township 6, Range 12!

NEW HAMPSHIRE: Intervale! Mt. Moosilauke!

MASSACHUSETTS: Reading! East Bridgewater! Lake Watuppa, Fall River! Milford Pond, Swansea!

RHODE ISLAND: Nyatt!

This species is recorded among the rare desmids of the United States by L. N. Johnson, but it has been found frequently in New England, as the above records show. It has usually been common in the collections in which it has occurred. The delicate striae are very noticeable on specimens from certain localities. Those from Lake Watuppa and Nyatt had them in the majority of cases.

4*a*. **Closterium didymotocum Johnsonii** (W. & G. S. West) comb. nov.

Closterium Johnsonii W. & G. S. West, Jour. Linn. Soc. **33**: 284. *pl. 16. f. 1, 2.* 1898.

Cells more slender, about 17 times as long as wide, central portion nearly straight with subparallel sides, ends gradually attenuated and slightly curved; apices broad, truncated; ends with the darker annular thickening, yellow-brown, smooth.

Length 357 μ; breadth 21 μ; apices 12 μ.

NEW HAMPSHIRE: Plymouth! (Type, H. J., *no. 655.*)

The type of *C. Johnsonii* now in the collection at Harvard University has been examined carefully. I am not satisfied that the apparent sigmoid character of one semi-cell is more than accidental. The other semi-cell does not show it. The ends have the annular thickenings and the broad truncate apices of *C. didymotocum.* It is more attenuated than the typical and slightly smaller.

5. CLOSTERIUM MACILENTUM Bréb.

Closterium macilentum Bréb. Mém. Soc. Sci. Nat. Cherbourg **4**: 53. *pl. 2. f. 36.* 1856. — Wolle, Desm. U. S. 38. *pl. 6. f. 6.* 1884. — W. & G. S. West, Brit. Desm. **1**: 118. *pl. 12. f. 8–10.* 1904.

Cells of medium size, 25–35 times as long as wide, nearly straight, slightly curved toward the ends, apices obtusely rounded; cell-wall smooth, colorless.

Length 360–527 μ; breadth 11–16 μ; apices 4.5–6 μ. (PLATE 3, FIGURE 17.)

NEW HAMPSHIRE: Intervale!

MASSACHUSETTS: Carver's Pond, Bridgewater! Lake Watuppa, Fall River! Eastham!

6. CLOSTERIUM ANGUSTATUM Kütz.

Closterium angustatum Kütz. Phyc. Germ. 132. 1845. — Wolle, Desm. U. S. 40. *pl. 6. f. 21.* 1884. — W. & G. S. West, Brit. Desm. **1**: 119. *pl. 12. f. 11–13.* 1904.

Cells of medium size, moderately curved, 10–18 times as long as wide, apices truncately rounded; cell-wall reddish- or yellowish-brown, ends darker, usually 4 costae visible across the cell.

Length 240 μ; breadth 20 μ; apices 15 μ.

MAINE: Orono (*W. West*).

MASSACHUSETTS: Berkshire Mts. (*Wolle*); Tewksbury (*Lagerheim*).

RHODE ISLAND: Wainskut Pond, North Providence (*Bailey*).

Although this species has several times been reported from New England, all the New England specimens seen in the material I have examined belong to the following variety, and some of the previously recorded specimens are placed there.

7. CLOSTERIUM ANGUSTATUM CLAVATUM Hastings

Closterium angustatum clavatum Hastings, Am. Month. Micr. Jour. **13**: 155. *pl. 1. f. 7.* 1892. — Johnson, Bull. Torrey Club **22**: 291. *pl. 239. f. 6.* 1895.

Cells larger than the typical, ends tumid and clavate; cell-wall with 3 or 4 costae visible, often spirally twisted at the apices.

Length 355–650 μ; breadth 21–34 μ; apices 15–21 μ. (PLATE 3, FIGURE 12.)

MAINE: Mud Pond, Township 6, Range 12!

NEW HAMPSHIRE: Hanover (*Edwards*); Saco Lake (*Wood*); Rochester (*Hastings*); North Woodstock!

MASSACHUSETTS: East Bridgewater! Lake Watuppa, Fall River!

CONNECTICUT: Bridgeport, scarce (*Johnson*).

Wolle describes var. *reticulatum* and var. *decussatum*, both of which evidently apply to the same thing. Just what Wolle had, it

is difficult to determine. His specimens were from Mt. Everett, Massachusetts. Collections which I made there in May, 1907, failed to show anything which might suggest these forms.

8. CLOSTERIUM COSTATUM Corda

Closterium costatum Corda, Alm. de Carlsbad, 185, etc. *pl. 5. f. 61–63.* 1834. — Wolle, Desm. U. S. 42. *pl. 6. f. 19.* 1884. — W. & G. S. West, Brit. Desm. **1**: 120. *pl. 13. f. 1–3.* 1904.

Cells of medium size, 7–9 times as long as wide, moderately curved, apices rounded; cell-wall dark yellowish-brown, with 6–8 costae visible across the cell.

Length 215–410 μ; breadth 29–44 μ. (PLATE 3, FIGURE 13.)

MAINE: Orono (*W. West*).

NEW HAMPSHIRE: Pudding Pond, North Conway! Intervale!

MASSACHUSETTS: Amherst (*W. West*); Tewksbury (*Lagerheim*); Lake Quinsigamond, Worcester (*Stone*); Reading! West Bridgewater! Gay Head! Almanac Pond, Nantucket!

8a. CLOSTERIUM COSTATUM WESTII Cushman

Closterium costatum Corda, *forma*, W. & G. S. West, Trans. Linn. Soc. Bot. II. **5**: 237. *pl. 13. f. 23, 24.* 1896.

Closterium costatum Westii Cushman, Rhodora **7**: 114. 1905.

Cells only slightly curved, smaller than the typical, tumid in the middle, apices truncate; cell-membrane punctate between the costae.

Length 230–300 μ; breadth 25–32 μ; apices 10–12 μ. (PLATE 3, FIGURE 14.)

NEW HAMPSHIRE: North Woodstock! Pudding Pond, North Conway!

MASSACHUSETTS: Gay Head, Marthas Vineyard!

9. CLOSTERIUM REGULARE Bréb.

Closterium regulare Bréb. Mém. Soc. Sci. Nat. Cherbourg **4**: 148. *pl. 2. f. 35.* 1856. — W. & G. S. West, Brit. Desm. **1**: 122. *pl. 13. f. 4–6.* 1904.

Cells of medium size, 7–9 times as long as wide, moderately curved, apices truncately or angularly rounded; cell-wall light yellowish-brown, with 10–12 costae visible across the cell.

Length 230–310 μ; breadth 25–37 μ; apices 6.5–9.5 μ. (PLATE 3, FIGURE 15.)

NEW HAMPSHIRE: Intervale!

MASSACHUSETTS: Lake Watuppa, Fall River!

RHODE ISLAND: Nyatt!

10. CLOSTERIUM STRIOLATUM Ehrenb.

Closterium striolatum Ehrenb. Phys. Abh. Akad. Wiss. Berlin **1830**: 68. 1832. — Wolle, F.-W. Alg. U. S. 24. *pl. 55. f. 5–8*; Desm. U. S. 44. *pl. 6. f. 5–8. pl. 7. f. 8, 20.* 1892. — W. & G. S. West, Brit. Desm. **1**: 122. *pl. 13. f. 7–16.* 1904.

Cells of medium size, moderately curved, 8–12 times as long as wide, apices broadly truncate, angles rounded; cell-wall yellowish-brown, with 12–20 striae visible across the cell.

Length 220–375 μ; breadth 19–44 μ; apices 9–12.5 μ. (PLATE 3, FIGURE 10.)

MAINE: Basin Mills and Orono (*Harvey*).

NEW HAMPSHIRE: Saco Lake (*Wood*); Meredith and Plymouth (*Johnson*).

MASSACHUSETTS: Amherst (*W. West*); Lake Quinsigamond, Worcester (*Stone*); near Salem (*Bailey*); Bridgewater! Pondville! South Framingham! Reading! Lake Watuppa, Fall River! Eastham (zygospores)!

10*a*. CLOSTERIUM STRIOLATUM ERECTUM Klebs

Closterium striolatum erectum Klebs, Schrift. Physik.-oekonom. Gesells. Königsberg **22**: 14. *pl. 2. f. 3, 4 b, 4 c, 10.* 1879.

Resembling the typical, but with the median portion straight and the ends abruptly curved.

Length 360 μ; breadth 34 μ. (PLATE 3, FIGURE 11.)

NEW HAMPSHIRE: North Woodstock!

Although this variety may be connected with the typical form, it was very common at this one locality and the typical form was absent.

11. CLOSTERIUM INTERMEDIUM Ralfs

Closterium intermedium Ralfs, Brit. Desm. 171. *pl. 29. f. 2h, 3.* 1848.— W. & G. S. West, Brit. Desm. **1**: 125. *pl. 14. f. 1–5.* 1904.

C. striolatum Ehrenb., var. *intermedium* Cushman, Rhodora **5**: 255. 1903; **7**: 115. 1905.

C. striolatum Ehrenb., var. *elongatum* Cushman, *l. c.* 115. 1905.
C. subdirectum West, Jour. Roy. Micr. Soc. **1889**: 17. *pl. 3. f. 16.* 1889.

Cells of medium size, 11–13 times as long as wide, moderately curved, apices truncate with rounded angles; cell-wall yellowish-brown, with 7–10 striae visible across the cell.

Length 220–370 μ; breadth 19–28 μ; apices 8–11 μ.

MAINE: Kittery!

NEW HAMPSHIRE: Intervale!

MASSACHUSETTS: Amherst (*W. West*); South Framingham! Plainville! Pondville! East Bridgewater! North Watuppa Lake, Fall River! Westport! Swansea!

RHODE ISLAND: Nyatt!

*12. CLOSTERIUM ULNA Focke

Closterium Ulna Focke, Physiologische Studien 59. *pl. 3. f. 30.* 1847.—W. & G. S. West, Brit. Desm. **1**: 127. *pl. 14. f. 7–9.* 1904.

Cells of medium size, about 30 times as long as wide, apices truncate; cell-wall slightly yellow, with 15–20 fine striae visible across the cell.

Length 370 μ; breadth 11.5 μ; apices 7.5 μ. (PLATE 3, FIGURE 9.)

MASSACHUSETTS: Randolph!

The specimens from this locality were very elongate, otherwise they were typical.

13. CLOSTERIUM JUNCIDUM Ralfs

Closterium juncidum Ralfs, Brit. Desm. 172. *pl. 29. f. 6.* 1848. — Wolle, Desm. U. S. 38. *pl. 6. f. 2, 3.* 1884.—W. & G. S. West, Brit. Desm. **1**: 128. *pl. 14. f. 10–14.* 1904.

Cells long and slender, 30–45 times as long as wide, median portion straight and of uniform width, apices slightly curved, obtusely rounded; cell-wall yellowish-brown, with 5–7 striae visible across the cell.

Length 210–375 μ; breadth 6–8.5 μ; apices 3.5 μ. (PLATE 3, FIGURE 18.)

MAINE: Orono (*Harvey*); Kittery!

NEW HAMPSHIRE: Saco Lake (*Wood*); Pudding Pond, North Conway!

MASSACHUSETTS: Lake Quinsigamond, Worcester (*Stone*); South Framingham! Lake Watuppa, Fall River!

* 13*a*. CLOSTERIUM JUNCIDUM ELONGATUM Roy & Biss.

Closterium juncidum elongatum Roy & Biss. Ann. Scot. Nat. Hist. 245. 1894. — W. & G. S. West, Brit. Desm. **1**: 130. 1904.

Cells broader than in the typical form, 26–36 times as long as wide.

Length 310–381 μ; breadth 11.5–12 μ; apices 7 μ.

MASSACHUSETTS: Tewksbury (*Lagerheim*); Lake Watuppa, Fall River!

* 13*b*. CLOSTERIUM JUNCIDUM BREVIUS Roy

Closterium juncidum var. β Ralfs, Brit. Desm. 172. *pl. 29. f. 7.* 1848.

Closterium juncidum β *brevior* Roy, Jour. Bot. **28**: 336. 1890. — W. & G. S. West, Brit. Desm. **1**: 129. *pl. 14. f. 15, 16.* 1904.

Cells relatively broader than in the typical, 12–15 times as long as wide.

Length 165–210 μ; breadth 12.5–13.5 μ. (PLATE 3, FIGURE 19.)

MASSACHUSETTS: Lake Watuppa, Fall River!

14. CLOSTERIUM DIANAE Ehrenb.

Closterium Dianae Ehrenb. Infusionsth. 92. *pl. 5. f. xvii. 1–6.* 1838. — Wolle, Desm. U. S. 45. *pl. 7. f. 9. pl. 8. f. 4.* 1884. — W. & G. S. West, Brit. Desm. **1**: 130. *pl. 15. f. 1–6.* 1904.

Closterium acuminatum Wolle, Desm. U. S. 44. *pl. 7. f. 18, 19.* 1884.

Cells of medium size, strongly curved, attenuated to the obtusely rounded apices, the dorsal margin of each being obliquely truncated and thickened; cell-wall yellowish-brown, smooth; zygospores spherical.

Length 325–360 μ; breadth 25–31 μ; diameter of zygospores 36–40 μ. (PLATE 4, FIGURE 12.)

MAINE: Orono (*Harvey, W. West*); Kittery, frequent!

NEW HAMPSHIRE: Pudding Pond, North Conway!

MASSACHUSETTS: Amherst (*W. West*); Lake Quinsigamond,

Worcester (*Stone*); Mt. Everett (*Wolle*); Bridgewater! Reading, (zygospores)!

RHODE ISLAND: Wainskut Pond, North Providence (*Bailey*).

The obliquely truncated and thickened dorsal margin of the apices is very characteristic.

* 14*a*. CLOSTERIUM DIANAE ARCUATUM (Bréb.) Rabenh.

Closterium arcuatum Bréb. in Ralfs, Brit. Desm. 219. 1848.

Closterium Dianae arcuatum Rabenh. Flor. Europ. Alg. **3**: 133. 1868. — Wolle, Desm. U. S. *pl. 7. f. 8.* 1884. — W. & G. S. West, Brit. Desm. **1**: 131. *pl. 15. f. 21, 22.* 1904.

Slightly smaller and more strongly curved than in the typical form, about 10 times as long as wide.

Length 190 μ; breadth 19 μ.

MASSACHUSETTS: Cedar Pond, North Falmouth!

* 15. CLOSTERIUM PSEUDODIANAE Roy

Closterium Pseudodianae Roy, Scottish Naturalist **10**: 201. 1890. — W. & G. S. West, Brit. Desm. **1**: 132. *pl. 15. f. 7, 8.* 1904.

Cells of medium size, moderately curved, 15–20 times as long as wide, apices narrow and obtuse; cell-wall colorless or light yellowish-brown, smooth.

Length 155–254 μ; breadth 11.5–12.5 μ; apices 2.5–3 μ. (PLATE 5, FIGURE 1.)

MASSACHUSETTS: North Lake Watuppa, Fall River! Cedar Pond, North Falmouth!

RHODE ISLAND: Nyatt!

This species is narrower and less curved than *C. Dianae* but is not nearly so common. It has not previously been reported from the United States.

16. CLOSTERIUM PARVULUM Näg.

Closterium parvulum Näg. Gatt. einz. Alg. 106. *pl. 6 C. f. 2* (in part). 1849. — Wolle, Desm. U. S. 45. *pl. 7. f. 7. pl. 8. f. 16.* 1884. — W. & G. S. West, Brit. Desm. **1**: 133. *pl. 15. f. 9–12.* 1904.

Closterium calosporum Cushman, Rhodora **7**: 115. 1905.

Cells small, strongly curved, 10–12 times as long as wide, apices acutely rounded; cell-wall colorless, smooth.

Length 108–170 μ; breadth 10–15 μ; apices 1.5–2.3 μ. (PLATE 3, FIGURES 6, 7.)

MAINE: Orono (*Harvey*); Mud Pond, Township 6, Range 12!

NEW HAMPSHIRE: Pudding Pond, North Conway!

MASSACHUSETTS: Amherst (*W. West*); Lake Quinsigamond, Worcester (*Stone*); South Framingham! Medford!

In the absence of zygospores, the *C. calosporum* reported from North Conway, N. H. is included here.

17. CLOSTERIUM JENNERI Ralfs

Closterium Jenneri Ralfs, Brit. Desm. 167. *pl. 28. f. 6.* 1848. — Wolle, Desm. U. S. 44. *pl. 7. f. 5.* 1884. — W. & G. S. West, Brit. Desm. 1: 134. *pl. 15. f. 23–25.* 1904.

Cells small, strongly curved, especially toward the ends, the middle portion nearly straight, apices obtusely rounded; cell-wall colorless, smooth.

Length 40–75 μ; breadth 6–10 μ. (PLATE 5, FIGURES 3, 4.)

MAINE: Mud Pond, Township 6, Range 12!

MASSACHUSETTS: Amherst (*W. West*); Lake Quinsigamond, Worcester (*Stone*); Misery Island, off Beverly, rare! Lake Watuppa, Fall River!

RHODE ISLAND: Wainskut Pond, North Providence (*Bailey*); Portsmouth! Nyatt!

18. CLOSTERIUM INCURVUM Bréb.

Closterium incurvum Bréb. Mém. Soc. Sci. Nat. Cherbourg 4: 150. *pl. 2. f. 47.* 1856. — W. & G. S. West, Brit. Desm. 1: 136. *pl. 15. f. 28–30.* 1904.

Cells very small, strongly curved, 5–6 times as long as wide, apices acute; cell-wall colorless, smooth.

Length 62–68 μ; breadth 11–12 μ. (PLATE 3, FIGURE 8.)

NEW HAMPSHIRE: Intervale!

MASSACHUSETTS: Reading! Gibbs and Almanac Ponds, Nantucket!

19. CLOSTERIUM VENUS Kütz.

Closterium Venus Kütz. Phyc. Germ. 130. 1845. — Wolle, Desm. U. S. 44. *pl. 7. f. 6.* 1884. — W. & G. S. West, Brit. Desm. 1: 137. *pl. 15. f. 15–20.* 1904.

Cells small, strongly curved, 8–9 times as long as wide, apices acute; cell-wall colorless and smooth.

Length 56–87 μ; breadth 7–10.5 μ. (PLATE 5, FIGURE 2.)

MAINE: Oldtown (*Harvey*); Kittery!

NEW HAMPSHIRE: Bog near Noone's Station! Mt. Moosilauke, common!

MASSACHUSETTS: Amherst (*W. West*); Winchester! Reading! Wellesley! Wakefield! Lake Watuppa, Fall River! Westport! Cedar Pond, North Falmouth! Nantucket!

RHODE ISLAND: Nyatt!

This is one of our commoner species.

20. CLOSTERIUM EBORACENSE Turner

Closterium eboracense Turner, in Cooke, Brit. Desm. 37. *pl. 65. f. 1.* 1886.—W. & G. S. West, Brit. Desm. 1: 140. *pl. 16. f. 7, 8.* 1904.

Closterium Cucumis Wolle (non Ehrenb.), Desm. U. S. 40. *pl. 6. f. 17, 18.* 1884.

Cells of medium size, 5–6 times as long as wide, outer margin strongly curved, inner margin very slightly concave, apices bluntly rounded; cell-wall colorless and smooth.

Length 248–325 μ; breadth 48–50 μ.

MAINE: Oldtown and Orono (*Harvey*).

MASSACHUSETTS: Amherst (*W. West*); Stony Brook, Weston! Gay Head, Marthas Vineyard!

The specimens reported from America as *C. Cucumis* are as a rule *C. eboracense*, as the work of Wolle was followed by many writers.

21. CLOSTERIUM LEIBLEINII Kütz.

Closterium Leibleinii Kütz. Linnaea 8: 596. *pl. 18. f. 79.* 1834.—Wolle, Desm U. S. 46. *pl. 7. f. 13, 14, 20.* 1884.—W. & G. S. West, Brit. Desm. 1: 141. *pl. 16. f. 9–14.* 1904.

Cells of medium size, strongly curved, 5–6 times as long as wide, apices acutely rounded; cell-wall colorless and smooth.

Length 112–190 μ; breadth 18–34 μ. (PLATE 4, FIGURE 9.)

MAINE: Orono (*W. West*); Kittery!

MASSACHUSETTS: Amherst (*W. West*); South Framingham! Winchester! Myricks! East Bridgewater! Cedar Pond, North Falmouth! Eastham, abundant! Nantucket!

RHODE ISLAND: near Providence (*Bailey*); Nyatt!

22. CLOSTERIUM MONILIFERUM (Bory) Ehrenb.

Lunulina monilifera Bory, Encycl. Meth. Hist. Zooph. **2**: 501. *pl. 3. f. 22, 25, 27.* 1824.

Closterium moniliferum Ehrenb. Infus. 91. *pl. 5. f. 16* (in part). — Wolle, Desm. U. S. 45. *pl. 7. f. 15.* 1884. — W. & G. S. West, Brit. Desm. **1**: 142. *pl. 16. f. 15, 16.* 1904.

C. Leibleinii Kütz., var. *curtum* West, Jour. Roy. Micr. Soc. **1889**: 17. *pl. 2. f. 8.* 1889.

Cells larger than in the preceding, stout, moderately curved, about 6 times as long as wide, apices obtusely rounded; cell-wall colorless and smooth.

Length 200–325 μ; breadth 31–56 μ. (PLATE 4, FIGURE 10.)

MAINE: Orono (*Harvey*); Gorham (*W. West*); Bridgeton! Spencer Pond, East Middlesex!

NEW HAMPSHIRE: Intervale!

MASSACHUSETTS: Reading! Wakefield! Pondville! Halifax! Lake Watuppa, Fall River! Gay Head, Marthas Vineyard! Nantucket!

RHODE ISLAND: Wainskut Pond, North Providence (*Bailey*).

23. CLOSTERIUM EHRENBERGII Menegh.

Closterium Ehrenbergii Menegh. Linnaea **14**: 232. 1840.—Wolle, Desm. U. S. 45. *pl. 7. f. 16.* 1884.— W. & G. S. West, Brit. Desm. **1**: 143. *pl. 17. f. 1–4.* 1904.

C. robustum Hastings, Am. Month. Micr. Jour. **13**: 154. *pl. 1. f. 4.* 1892.

Cells large, stout, moderately curved, about 4 times as long as wide, apices obtusely rounded; cell-wall colorless and smooth.

Length 400–480 μ; breadth 78–125 μ. (PLATE 4, FIGURE 11.)

MAINE: Near Penobscot River at Great Works and Orono (*Harvey*); Mud Pond, Township 6, Range 12!

NEW HAMPSHIRE: Page Brook, Rochester (*Hastings*).

MASSACHUSETTS: Amherst (*W. West*); Lake Quinsigamond, Worcester (*Stone*); Bridgewater! Watuppa, Fall River! Eastham!

24. CLOSTERIUM ACEROSUM (Schrank) Ehrenb.

Vibrio acerosus Schrank, Fauna Boica **3**^{2}: 47. *no. 2848.* 1803.

Closterium acerosum Ehrenb. Symb. Phys. Phytozoa, *pl. 2. f. 9.* 1828; Infus. 93. *pl. 2. f. 15. pl. 6. f. 1. pl. 22. 1. 5.* 1838.

— Wolle, Desm. U. S. 41. *pl. 6. f. 7, 11. pl. 8. f. 17.* 1884. — W. & G. S. West, Brit. Desm. **1**: 146. *pl. 18. f. 2–5.* 1904.

Cells large, elongate, only slightly curved, about 10–12 times as long as wide, gradually tapering to the narrow rounded-truncate apices; cell-wall usually colorless and smooth but in old specimens the cell-wall becomes brownish, sometimes finely striate and the apices thickened just back from the tips.

Length 355–480 μ; breadth 33–42 μ.

MAINE: Orono (*Harvey, W. West*); Mud Pond, Township 6, Range 12!

NEW HAMPSHIRE: Intervale!

MASSACHUSETTS: Lake Quinsigamond, Worcester (*Stone*); Tewksbury (*Lagerheim*); Stony Brook, Weston! Carvers Pond, Bridgewater! Eastham!

24*a*. CLOSTERIUM ACEROSUM ELONGATUM Bréb.

Closterium acerosum, var. *elongatum* Bréb. *l. c.* 152. 1856. — W. & G. S. West, Brit. Desm. **1**: 148. *pl. 18. f. 1.* 1904.

Longer and larger than the typical form; cell-wall yellowish-brown with more distinct striations.

Length 500–651 μ; breadth 37–54 μ. (PLATE 4, FIGURE 6.)

MASSACHUSETTS: Amherst (*W. West*); Medford! Lake Watuppa, Fall River! Nantucket!

25. CLOSTERIUM LANCEOLATUM Kütz.

Closterium lanceolatum Kütz. Phyc. Germ. 130. 1845. — Wolle, Desm. U. S. 39. *pl. 8. f. 14.* 1884. — W. & G. S. West, Brit. Desm. **1**: 149. *pl. 17. f. 9, 10. pl. 18. f. 7.* 1904.

Cells large 4½–7 times as long as wide, nearly straight, outer margin slightly curved, inner margin often slightly convex, gradually attenuated to the acutely rounded apices; cell-wall colorless, smooth.

Length 390–415 μ; breadth 70–93 μ.

VERMONT: Lake Champlain!

MASSACHUSETTS: Amherst (*W. West*); South Framingham!

RHODE ISLAND: Nyatt!

26. CLOSTERIUM LUNULA (Müll.) Nitzsch

Vibrio Lunula Müll. Naturforsch. **20**: 142. 1784.

Closterium Lunula Nitzsch, Neue Schrift. Nat. Gesells. Halle **3**: 60,

67. 1817. — Wolle, Desm. U. S. 40. *pl. 50. f. 26.* 1884. — W. & G. S. West, Brit. Desm. **1**: 150. *pl. 18. f. 8, 9.* 1904.

Cells large, stout, 6–7 times as long as wide; axis nearly straight, outer margin curved, inner margin nearly straight, or slightly tumid in the middle, becoming somewhat concave toward the ends, apices often slightly recurved, obtusely rounded; cell-wall colorless, smooth.

Length 465–650 μ; breadth 71–93 μ; apices 12–15 μ. (PLATE 4, FIGURE 18.)

MAINE: Oldtown and Great Works (*Harvey*).

NEW HAMPSHIRE: Pudding Pond, North Conway, common! North Woodstock!

MASSACHUSETTS: Amherst (*W. West*); near Salem (*Bailey*); Misery Island, off Beverly! Reading! Gay Head, Marthas Vineyard!

RHODE ISLAND: Nyatt!

Wolle's figure of this species is not a good one, as he notes.

26*a*. CLOSTERIUM LUNULA INTERMEDIUM Gutw.

Closterium Lunula, var. *intermedium* Gutw. Rozpraw. Wydz. matem.-przyr. Akad. Umiej. Krakow. **32**: 39. *pl. 6. f. 17.* 1897. — W. & G. S. West, Brit. Desm. **1**: 152. *pl. 18. f. 12.* 1904.

Cells with the outer margin more convex, the inner margin broadly convex, ends abruptly narrowed to the truncate apices.

Length 440–540 μ; breadth 65–94 μ.

MASSACHUSETTS: Lake Watuppa, Fall River! Gibbs Pond, Nantucket!

26*b*. CLOSTERIUM LUNULA MINUS W. & G. S. West

Closterium Lunula, forma *minor* W. & G. S. West, Brit. Desm. **1**: 151. 1904.

Smaller than the typical form; the cell-wall faintly straw-colored.

Length 403 μ; breadth 56 μ.

NEW HAMPSHIRE: Intervale!

* 26*c*. CLOSTERIUM LUNULA MAXIMUM Borge

Closterium Lunula, var. *maximum* Borge, Arkiv för Botanik **1**: 77. *pl. 1. f. 9.* 1903.

Cells very large, about four times as long as wide, slightly concave close to the apices, dorsal margin broadly convex, ventral margin slightly tumid.

Length 800 μ; breadth 170 μ. (PLATE 5, FIGURE 7.)

MASSACHUSETTS: Milford Pond, Swansea!

This is one of the largest of our desmids and is visible without a lens.

*27. CLOSTERIUM LITTORALE Gay

Closterium littorale Gay, Monogr. Conj. 75. *pl. 2. f. 17.* 1884. — W. & G. S. West, Brit. Desm. **1**: 155. *pl. 19. f. 14.* 1904.

Cells rather small, about nine times as long as wide, slightly curved, inner margin tumid in the middle, gradually attenuated to the obtusely rounded apices; cell-wall colorless, smooth; zygospore globose and smooth.

Length 160–164 μ; breadth 18–18.5 μ; diameter of zygospore 28 μ. (PLATE 4, FIGURE 8; PLATE 5, FIGURE 12.)

MASSACHUSETTS: Eastham, with zygospores!

This is the first record for the zygospore of this species. New to United States.

28. CLOSTERIUM TUMIDUM Johnson

Closterium tumidum Johnson, Bull. Torrey Club **22**: 291. *pl. 239. f. 4.* 1895. — W. & G. S. West, Brit. Desm. **1**: 156. *pl. 19. f. 15–18.* 1904.

Closterium Cornu, forma *major* West, Jour. Bot. 339. 1888.

Cells rather small, 8–9 times as long as wide, slightly curved, inner margin prominently tumid in the middle, gradually attenuated to the truncately rounded apices; cell-wall colorless, smooth.

Length 130–150 μ; breadth 14–18 μ.

MAINE: Orono (*W. West*).

NEW HAMPSHIRE: Holderness, frequent (*Johnson, W. & G. S. West*); Pudding Pond, North Conway!

29. CLOSTERIUM ABRUPTUM West

Closterium abruptum West, Jour. Roy. Micr. Soc. **1892**: 719. *pl. 9. f. 1.* 1892. — Johnson, Bull. Torrey Club **22**: 291. *pl. 239. f. 5.* 1895. — W. & G. S. West, Trans. Linn. Soc. Bot. II. **5**: 236. *pl. 13. f. 14, 15.* 1896; Brit. Desm. **1**: 158. *pl. 20. f. 6–10.* 1904.

Cells rather small, about 12 times as long as wide, slightly

curved, median portion nearly straight, ends more curved, gradually attenuated to the broadly truncate apices; cell-wall colorless or slightly yellowish-brown, smooth.

Length 84–200 μ; breadth 12.5–15.5 μ; apices 6 μ.

MAINE: Orono (*W. West*).

NEW HAMPSHIRE: Holderness, frequent (*Johnson*).

MASSACHUSETTS: Gibbs Pond, Nantucket!

* 30. CLOSTERIUM TOXON West

Closterium toxon West, Jour. Linn. Soc. Bot. **19**: 121. *pl. 19. f. 14.* 1892. — W. & G. S. West, Brit. Desm. **1**: 160. *pl. 20. f. 13, 14.* 1904.

Cells linear, 25 or more times as long as wide, straight with nearly parallel margins, except toward the ends, which are slightly curved, apices subtruncate; cell-wall colorless or a light yellowish-brown, smooth.

Length 242–365 μ; breadth 9–12 μ; apices 4.5–8 μ. (PLATE 4, FIGURE 17.)

MASSACHUSETTS: Lake Watuppa, Fall River! Cedar Pond, North Falmouth!

* 31. CLOSTERIUM PRAELONGUM Bréb.

Closterium praelongum Bréb. *l. c.* 152. *pl. 2. f. 41.* 1856. — Wolle(?), F.-W. Alg. U. S. 24. *pl. 55. f. 15, 16.* 1887. — Desm. U. S. 43. *pl. 6. f. 15, 16.* 1892. — W. & G. S. West, Brit. Desm. **1**: 164. *pl. 21. f. 1, 2.* 1904.

Cells very elongate, about 35 times as long as wide, very gently curved, inner margin slightly concave for its entire length, gradually attenuated to the somewhat recurved ends, apices obtuse; cell-wall colorless, smooth.

Length 520 μ; breadth 14 μ; apex 5 μ.

MASSACHUSETTS: Lake Watuppa, Fall River!

Wolle figures a striate form with colored cell-wall under this name. The breadth given is rather large also for this species.

32. CLOSTERIUM STRIGOSUM Bréb.

Closterium strigosum Bréb. *l. c.* 153. *pl. 2. f. 43.* 1856. — Wolle, Desm. U. S. 42. *pl. 6. f. 13, 14. pl. 53. f. 9, 10.* 1884. — W. & G. S. West, Brit. Desm. **1**: 165. *pl. 21. f. 6, 7.* 1904.

Cells of medium size, 12–18 times as long as wide, slightly curved, nearly straight in the middle with the ends more curved, apices subacute; cell-wall colorless, smooth.

Length 170–294 μ; breadth 13–16 μ.

MAINE: Orono (*Harvey*).

NEW HAMPSHIRE: Pudding Pond, North Conway!

MASSACHUSETTS: Amherst (*W. West*); Winchester!

33. CLOSTERIUM GRACILE Bréb.

Closterium gracile Bréb. in Cheval. Microscop. 272. 1839.—Wolle, Desm. U. S. 39. *pl. 6. f. 4, 5.* 1884.—W. & G. S. West, Brit. Desm. **1**: 166. *pl. 21. f. 8–12.* 1904.

C. subtile Harvey, Bull. Torrey Club **19**: 121. 1892.—Cushman, Rhodora **5**: 252. 1903.

Cells small, linear, about 40 times as long as wide, median portion straight with parallel margins, ends gradually attenuated and somewhat curved, apices obtuse; cell-wall colorless and smooth.

Length 172–264 μ; breadth 5–6.2 μ; apices 2.8 μ.

MAINE: Orono (*W. West, Harvey*).

MASSACHUSETTS: Lake Watuppa, Fall River! Misery Island, off Beverly!

RHODE ISLAND: Nyatt!

* 33*a*. CLOSTERIUM GRACILE ELONGATUM W. & G. S. West

Closterium gracile var. *elongatum* W. & G. S. West, Brit. Desm. **1**: 168. *pl. 21. f. 14–16.* 1904.

Cells very elongate, over 100 times as long as wide, otherwise much like the typical.

Length 355 μ; breadth 3.2 μ; apices 1.8 μ.

MASSACHUSETTS: Cedar Pond, North Falmouth!

* 33*b*. CLOSTERIUM GRACILE TENUE (Lemm.) W. & G. S. West

Closterium limneticum Lemm., var. *tenue* Lemm. Phytoplankton Sächsis. Teiche 28. *pl. 2. f. 42–44.* 1899.

C. gracile, var. *tenue* W. & G. S. West, Trans. Linn. Soc. Bot. II. **6**: 138. *pl. 18. f. 22, 23.* 1902; Brit. Desm. **1**: 168. *pl. 21. f. 13.* 1904.

Cells smaller and more slender than in the typical form of the species.

Length 78 μ; breadth 3 μ.

MASSACHUSETTS: Reading!

34. CLOSTERIUM ATTENUATUM Ehrenb.

Closterium attenuatum Ehrenb. Infus. 94. *pl. 6. f. 4.* 1838. — Wolle, Desm. U. S. 41. *pl. 8. f. 5.* 1884. — W. & G. S. West, Brit. Desm. **1**: 169. *pl. 22. f. 1–3.* 1904.

Cells large, about 11 times as long as wide, slightly curved, gradually attenuated toward the ends, where they are suddenly contracted into the obtusely rounded apices; cell-wall reddish-brown in color, with about 20 striae visible across its surface.

Length 465 μ; breadth 45 μ.

MAINE: Frog Pond, Orono (*Harvey*).

NEW HAMPSHIRE: Pudding Pond, North Conway!

35. CLOSTERIUM TURGIDUM Ehrenb.

Closterium turgidum Ehrenb. Infus. 95. *pl. 6. f. 7.* 1838. — Wolle, Desm. U. S. 41. *pl. 6. f. 15.* 1884. — W. & G. S. West, Brit. Desm. **1**: 170. *pl. 22. f. 4, 5.* 1904.

Cells large, somewhat curved, about 13 times as long as wide, ends recurved, apices subtruncate; cell-wall reddish-brown, with 30 or more fine striations visible across the surface.

Length 682 μ; breadth 53 μ; apices 12 μ.

MAINE: Orono (*W. West*).

MASSACHUSETTS: Near Salem (*Bailey*); Lake Watuppa, Fall River!

RHODE ISLAND: Providence (*Bailey*).

* 36. CLOSTERIUM PRITCHARDIANUM Arch.

Closterium Pritchardianum Arch. Proc. Dubl. Nat. Hist. Soc. **3**^{2}: 250. *pl. 12. f. 25–27.* 1862. — W. & G. S. West, Brit. Desm. **1**: 172. *pl. 22. f. 6–14.* 1904.

C. turgidum, forma *intermedium* Cushman, Rhodora **7**: 116. 1905.

Cells large, only slightly curved, about 15 times as long as wide, inner margins nearly straight, ends slightly recurved, apices truncate; cell-wall reddish-brown, with nearly 40 striae, composed of punctae across the surface.

Length 400 μ; breadth 28 μ; apices 7–9 μ. (PLATE 4, FIGURE 5.)

NEW HAMPSHIRE: Intervale!

37. CLOSTERIUM PRONUM Bréb.

Closterium pronum Bréb. Mém. Soc. Sc. Nat. Cherbourg **4**: 157. *pl. 2. f. 42.* 1856. — Wolle, F.-W. Alg. U. S. 25. *pl. 55. f. 22.*

1887; Desm. U. S. 50. *pl. 6. f. 22.* 1892.—W. & G. S. West, Brit. Desm. **1**: 173. *pl. 23. f. 1–3.* 1904.

Cells very elongate, about 50 times as long as wide, nearly straight, very gradually attenuated to the narrow but obtuse apices; cell-wall colorless or slightly yellowish-brown, smooth or with traces of a fine striation in the older specimens.

Length 320–375 μ; breadth 6–8.5 μ.

MAINE: Orono (*W. West*).

NEW HAMPSHIRE: Pudding Pond, North Conway!

*38. CLOSTERIUM ACICULARE T. West

Closterium aciculare T. West, Trans. Roy. Micr. Soc. **8**: 153. *pl. 7. f. 16.* 1860.—W. & G. S. West, Brit. Desm. **1**: 174. *pl. 26. f. 18, 19.* 1904.

Cells very elongate, 76 times as long as wide, median portion straight, ends somewhat incurved, attenuated very gradually to the acutely rounded apices; cell-wall colorless, smooth.

Length 380 μ; breadth 5 μ. (PLATE 4, FIGURE 7.)

MASSACHUSETTS: Lake Watuppa, Fall River!

Not previously reported from the United States.

39. CLOSTERIUM ACUTUM (Lyngb.) Bréb.

Echinella acuta Lyngb. Hydr. Dan. 209. *pl. 69. f. G.* 1819.
Closterium acutum Bréb. in Ralfs, Brit. Desm. 177. *pl. 30. f. 5. pl. 34. f. 5, a, b, d–f.* 1848.—Wolle, Desm. U. S. 44. *pl. 7. f. 11, 12.* 1884.—W. & G. S. West, Brit. Desm. **1**: 177. *pl. 23. f. 9–14.* 1904.

Cells small, about 25 times as long as wide, somewhat curved, inner margin not tumid, gradually attenuated to the acute apices; cell-wall colorless, smooth.

Length 150 μ; breadth 6 μ. (PLATE 5, FIGURE 11.)

MAINE: Orono (*W. West*).

MASSACHUSETTS: Amherst (*W. West*); Weston (*W. & G. S. West*); Reading!

*40. CLOSTERIUM SUBULATUM (Kütz.) Bréb.

Frustularia subulata Kütz. Syn. Diat. 538. *pl. 13. f. 1.* 1834.
Closterium subulatum Bréb. in Cheval. Microscop. 272. 1839.—W. & G. S. West, Brit. Desm. **1**: 179. *pl. 23. f. 16–19.* 1904.

Cells small, moderately curved, 12–20 times as long as wide, inner margin slightly tumid, gradually attenuated to the acutely rounded apices; cell-wall colorless and smooth.

Length 133–153 μ; breadth 7–12.5 μ. (PLATE 5, FIGURE 10.)

MASSACHUSETTS: Reading! Randolph! Lake Watuppa, Fall River!

41. CLOSTERIUM LINEATUM Ehrenb.

Closterium lineatum Ehrenb. Infus. 96. *pl. 6. f. 8.* 1838. — Wolle, Desm. U. S. 43. *pl. 6. f. 16.* 1884. — W. & G. S. West, Brit. Desm. **1**: 181. *pl. 24. f. 1–5.* 1904.

Cells large, elongated, 15–30 times as long as wide, moderately curved, median portion straight, ends more curved and gradually attenuated to the broad, truncately rounded apices; cell-wall yellowish or reddish-brown, with 12–20 striae across the surface; zygospores usually double, each part ovoid, walls smooth.

Length 540–775 μ; breadth 19–50 μ; apices 6–9 μ; diameter of zygospore 78 μ. (PLATE 4, FIGURE 3.)

MAINE: Scarboro (*W. West*).

MASSACHUSETTS: Near Salem (*Bailey*); Misery Island, off Beverly! Stony Brook, Weston! Cedar Pond, North Falmouth! Lake Watuppa, Fall River!

RHODE ISLAND: Wainskut Pond, North Providence (*Bailey*); Nyatt!

41*a*. CLOSTERIUM LINEATUM COSTATUM Wolle

Closterium lineatum Ehrenb. var. *costatum* Wolle, F.-W. Alg. U. S. 25. *pl. 61. f. 3.* 1887; Desm. U. S. 45. *pl. 10. f. 3.* 1892. — Johnson, Bull. Torrey Club **21**: 286. 1894.

Cells with coarser and fewer costae.

NEW HAMPSHIRE: Rochester (*Wolle*).

CONNECTICUT: Bridgeport (*Johnson, W. & G. S. West*).

*42. CLOSTERIUM RALFSII Bréb.

Closterium Ralfsii Bréb. in Ralfs, Brit. Desm. 174. *pl. 30. f. 2.* 1848. — Wolle, Desm. U. S. 46. *pl. 7. f. 10.* 1884. — W. & G. S. West, Brit. Desm. **1**: 182. *pl. 24. f. 6, 7.* 1904.

Cells large, 8–10 times as long as broad, moderately curved, inner margin much inflated for over half the length of the cell, somewhat abruptly attenuated toward the ends, which are somewhat produced and incurved, apices obtuse; cell-wall yellowish or reddish-brown with about 30 striae visible across the surface.

Length 428–496 μ; breadth 52–54 μ; apices 10–12 μ.

MASSACHUSETTS: Lake Watuppa, Fall River!

RHODE ISLAND: Nyatt!

42*a*. CLOSTERIUM RALFSII HYBRIDUM Rabenh.

Closterium Ralfsii, var. *hybridum* Rabenh. Krypt.-Fl. Sachs. 174. 1863. — W. & G. S. West, Jour. Linn. Soc. Bot. **33**: 284. 1898; Brit. Desm. **1**: 183. *pl. 24. f. 8–13.* 1904.

Cells longer than the typical, 13–16 times as long as broad, ventral inflation less prominent, apices subtruncate.

Length 356–682 μ; breadth 24–53 μ; apices 6–15 μ. (PLATE 5, FIGURES 8, 9.)

NEW HAMPSHIRE: Pudding Pond, North Conway!

MASSACHUSETTS: Winchester! Reading! Randolph! Eastham!

CONNECTICUT: Bridgeport (*W. & G. S. West*).

*42*b*. **Closterium Ralfsii immane** var. nov.

Cells similar to *C. Ralfsii*, but larger, very tumid, about 9–11 times as long as wide, rather abruptly attenuated to the rounded apices; cell-wall yellow or reddish-brown, with 30–50 striae across the surface.

Length 610–806 μ; breadth 67–75 μ; apices 11–12 μ. (PLATE 4, FIGURE 4.)

MASSACHUSETTS: Lake Watuppa, Fall River!

43. CLOSTERIUM BRAUNII Reinsch

Closterium Braunii Reinsch, Algenfl. Frank. 196. *pl. 12. f. 5.* 1867. — W. & G. S. West, Trans. Linn. Soc. Bot. **II. 5**: 236. *pl. 13. f. 16, 17.* 1896.

C. areolatum Wood, F.-W. Alg. 111. *pl. 11. f. 6.* 1874.—Wolle, Desm. U. S. 43. *pl. 8. f. 3, 4.* 1884.

C. maculatum Hastings, Amer. Month. Micr. Jour. **13**: 154. *pl. 1. f. 5.* 1892.—Johnson, Bull. Torrey Club **22**: 291. *pl. 239. f. 7.* 1895.

Cells large, very slightly curved or straight, central portion straight, then rather abruptly attenuated to the broadly truncate ends; cell-wall yellowish or reddish-brown, with 10–20 striae or costae, each made up of a double row of elongated granules.

Length 622 μ; breadth 43–50 μ; apices 10–11 μ.

MAINE: Scarboro (*W. & G. S. West*).

CONNECTICUT: Bridgeport, rare (*Johnson*).

44. CLOSTERIUM INTERVALICOLA Cushman

Closterium intervalicola Cushman, Rhodora **7**: 115. *pl. 61. f. 1.* 1905.

Cells rather small, about 10–12 times as long as wide, median portion nearly straight, but the ends decidedly curved, very slightly attenuated to the squarely truncated apices; cell-wall yellowish-brown with about 6 coarse striae across the surface.

Length 168 μ; breadth 15.5 μ; apices 6 μ. (PLATE 5, FIGURE 5.)

NEW HAMPSHIRE: Intervale!

*45. **Closterium Novæ-Angliæ** sp. nov.

Cells large, very elongate, 30–35 times as long as wide, very slightly curved, median portion straight, gradually attenuated to the incurved ends, ventral margin slightly tumid for a large part of its course near the middle, apices obtusely rounded; cell-wall yellowish or reddish-brown with a thickening and consequent darkening at the apices, 6–8 striae across the surface changing to granules near the apices.

Length 930–1080 μ; breadth 28–30 μ; apices 9–11 μ. (PLATE 4, FIGURE 1.)

MASSACHUSETTS: Lake Watuppa, Fall River!

This is one of the longest species recorded for this genus, being exceeded slightly by *C. mourense* Playfair, which is however 3–4 times as wide. This is near *C. Calamus* Playfair.

46. CLOSTERIUM DECORUM Bréb.

Closterium decorum Bréb. Mém. Soc. Sci. Nat. Cherbourg **4**: 151. *pl. 2. f. 39.* 1856.—Wolle, Desm. U. S. 43. *pl. 7. f. 1.* 1884.—W. & G. S. West, Brit. Desm. **1**: 184. *pl. 17. f. 7, 8.* 1904.

C. Delpontei Wolle, Bull. Torrey Club **12**: 2. 1885; F.-W. Alg. U. S. 25. *pl. 55. f. 9.* 1887; Desm. U. S. 45. *pl. 6. f. 9.* 1892.

Cells large, 12–16 times as long as wide, median portion of inner margin tumid, outer margin moderately curved, gradually attenuated to the truncately rounded apices; cell-wall yellowish-brown, with 15–18 striae across its surface.

Length 325–540 μ; breadth 24–48 μ; apices 6–9 μ. (PLATE 4, FIGURE 2.)

MAINE: Scarboro (*W. West*).

NEW HAMPSHIRE: Pudding Pond, North Conway! North Woodstock!

MASSACHUSETTS: Halifax! Lake Watuppa, Fall River! Gay Head, Marthas Vineyard! Gibbs Pond, Nantucket!

CONNECTICUT: Bridgeport and Easton (*Johnson, W. & G. S. West*).

47. CLOSTERIUM KÜTZINGII Bréb.

Closterium Kützingii Bréb. *l. c.* 156. *pl. 2. f. 40.* 1856.—Wolle, Desm. U. S. 47. *pl. 8. f. 8.* 1884.—W. & G. S. West, Brit. Desm. **1**: 186. *pl. 25. f. 6–11.* 1904.

Cells of medium size, 18–26 times as long as broad, nearly straight, median portion of cell fusiform, both margins of about the same convexity, attenuated at each end into long colorless processes, apices slightly incurved, rounded and slightly enlarged; cell-wall colorless or light yellowish-brown with 10–15 striae visible across the cell.

Length 325–460 μ; breadth 13–22 μ; apices 2.5–3 μ. (PLATE 4, FIGURE 13.)

MAINE: Pushau Stream (*Harvey*).

NEW HAMPSHIRE: Pudding Pond, North Conway! Hills Pond, Alton!

MASSACHUSETTS: Winchester! Randolph! Bridgewater! Lake Watuppa, Fall River! Westport! Cedar Pond, North Falmouth!

48. CLOSTERIUM ROSTRATUM Ehrenb.

Closterium rostratum Ehrenb. Phys. Abh. Akad. Wiss. Berlin 67. 1833.—Wolle, Desm. U. S. 46. *pl. 8. f. 1–3.* 1884.—W. & G. S. West, Brit. Desm. **1**: 188. *pl. 26. f. 1–5.* 1904.

Cells of medium size, 14–18 times as long as wide, slightly curved, median portion fusiform, inner margin more convex than the outer, attenuated at each end into long slightly incurved processes, shorter than in the preceding, ends slightly enlarged; cell-wall yellowish-brown with 25 or more striae across the surface.

Length 360–420 μ; breadth 19–25 μ; apices 3–4.5 μ. (PLATE 4, FIGURE 14.)

MAINE: Between Orono and Bangor (*W. West*); Pushau Pond (*Harvey*).

MASSACHUSETTS: Amherst (*W. West*); Bridgewater! Pondville! Lake Watuppa, Fall River!

48a. CLOSTERIUM ROSTRATUM BREVIROSTRATUM West

Closterium rostratum, var. *brevirostratum* W. West, Jour. Roy. Micr. So. **1889**: 17. *pl. 2. f. 9.* 1889.—W. & G. S. West, Brit. Desm. **1**: 189. *pl. 26. f. 6–8.* 1904.

Cells with shorter and less attenuated apices.

MASSACHUSETTS: Amherst (*W. West*).

49. CLOSTERIUM SETACEUM Ehrenb.

Closterium setaceum Ehrenb. Infus. 97. *pl. 6. f. 9.* 1838.—Wolle, Desm. U. S. 47. *pl. 8. f. 6, 7, 9–11.* 1884.—W. & G. S. West, Brit. Desm. 1: 190. *pl. 26. f. 9–13.* 1904.

Cells small, very slender, nearly straight, 35–45 times as long as wide, median portion fusiform, both margins equally convex, extremities prolonged, very slender; cell-wall colorless or slightly yellowish-brown, with about 12 or 13 fine striations across the surface; zygospore cruciform.

Length 235–465 μ; breadth 6–10 μ; apices 1–2.3 μ. (PLATE 4, FIGURES 15, 16.)

MAINE: Spencer Pond, East Middlesex!

NEW HAMPSHIRE: Pudding Pond, North Conway!

MASSACHUSETTS: Near Salem (*Bailey*); Reading! Randolph! Bridgewater, zygospores! Halifax! Lake Watuppa, Fall River! Nantucket!

RHODE ISLAND: Providence (*Bailey*); Nyatt!

The following forms of *Closterium* are not included in the above records:

"CLOSTERIUM DECUSSATUM Kg."

Recorded by Wolle from Gilder and other ponds on Mt. Everett, Mount Washington, Mass. What Wolle had is a perplexing thing, as I collected in Gilder Pond in 1907 and failed to find anything corresponding to many of the forms described by Wolle from that locality.

CLOSTERIUM NASUTUM Nordst.

Recorded by Wolle from "Ponds, Berkshire Mountains, Massachusetts." I have failed to find anything corresponding to this species.

CLOSTERIUM SUBANGUSTATUM West

This was described from Maine, "Bog between Orono and Bangor." It is close to some forms of *C. angustatum*, var. *clavatum* Hastings.

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Explanation of plates 3-5

PLATE 3

FIG. 1. *Closterium Cynthia* De Not. × 450.

" 2. " " " zygospore, × 450.

FIG. 3. *Closterium Archerianum* Cleve, × 350.
" 4. " *Malmei* Borge, × 200.
" 5. " " " apex, × 600.
" 6. " *parvulum* Näg. × 350.
" 7. " " " × 300.
" 8. " *incurvum* Bréb. × 300.
" 9. " *Ulna* Focke, × 350.
" 10. " *striolatum* Ehrenb. × 350.
" 11. " " *erectum* Klebs, × 350.
" 12. " *angustatum clavatum* Hastings, × 160.
" 13. " *costatum* Corda, × 250.
" 14. " " *Westii* Cushman, × 300.
" 15. " *regulare* Bréb. × 250.
" 16. " *didymotocum* Corda, × 350.
" 17. " *macilentum* Bréb. × 350.
" 18. " *juncidum* Ralfs, × 350.
" 19. " " *brevius* Roy, × 350.

PLATE 4

FIG. 1. *Closterium Novae-Angliae* sp. nov. × 125.
" 2. " *decorum* Bréb. × 350.
" 3. " *lineatum* Ehrenb. × 250.
" 4. " *Ralfsii immane* var. nov. × 225.
" 5. " *Pritchardianum* Arch. × 300.
" 6. " *acerosum elongatum* Bréb. × 150.
" 7. " *aciculare* T. West, × 250.
" 8. " *littorale* Gay, × 350.
" 9. " *Leibleinii* Kütz. × 300.
" 10. " *moniliferum* (Bory) Ehrenb. × 300.
" 11. " *Ehrenbergii* Menegh. × 250.
" 12. " *Dianae* Ehrenb. × 300.
" 13. " *Kützingii* Bréb. × 300.
" 14. " *rostratum* Ehrenb. × 300.
" 15. " *setaceum* " × 300.
" 16. " " zygospore, × 350.
" 17. " *Toxon* West, × 350.
" 18. " *Lunula* (Müll.) Nitzsch, × 125.

PLATE 5.

FIG. 1. *Closterium Pseudodianae* Roy, × 300.
" 2. " *Venus* Kütz. × 400.
" 3. " *Jenneri* Ralfs, × 350.
" 4. " " " × 450.
" 5. " *intervalicola* Cushman, × 300.
" 6. " *didymotocum* Corda, × 200.
" 7. " *Lunula maximum* Borge, × 125.
" 8. " *Ralfsii hybridum* Rabenh. × 150.
" 9. " " " " tip, × 450.
" 10. " *subulatum* (Kütz.) Bréb. × 450.
" 11. " *acutum* (Lyngb.) Bréb. × 400.
" 12. " *littorale* Gay, zygospore, × 400.

New ferns described as hybrids in the genus Dryopteris

PHILIP DOWELL

During the past five years I have been interested in the study of our native ferns in the field; and in our woodland swamps on Staten Island, and elsewhere in the vicinity of New York, I have occasionally met with forms that are not referable to any one recognized species but have characteristics in common with two known species. I do not refer to sports or mutants, which I have found also, and which can usually be referred definitely to some one species. The most plausible explanation in the case of these ferns is that they are hybrids, or that they have at least originated as hybrids between the two species whose characteristics they share, and as such they are here described in accordance with our American code. At all events they are new and deserve to be described and named. It should be borne in mind that these ferns grow in moist woodlands or in swampy places, where the conditions are favorable for the mingling of the gametes, and that natural hybrids may thus be easily produced. This was mentioned in *Torreya* **6**: 208, 1906, in an article entitled "Observations on the Occurrence of Boott's Fern," although at that time I was rather skeptical about hybrids among ferns. That hybrids do occur among ferns has been experimentally proved by Miss Margaret Slosson and others. By selecting and manipulating the prothallia with their antheridia and archegonia, Miss Slosson produced a hybrid between *Dryopteris cristata* and *D. marginalis* which looks the same as the natural hybrid described by G. E. Davenport as *D. cristata* × *marginalis*. Miss Slosson produced also, in a similar manner, a hybrid resembling *Asplenium ebenoides* Scott. In his "Index Filicum" Carl Christensen recognizes a number of hybrids, of which he includes three or four in the genus *Dryopteris*, four if we include *D. pittsfordensis*, of which he is not certain, but which is undoubtedly *D. marginalis* × *spinulosa*, as suggested by Miss Slosson when she described it. The other three recognized in the Index Filicum are *D. Filix-mas* × *spinulosa* (A. Br.) C. Chr., *D. cristata* × *marginalis*

Dav., and *D. cristata* × *spinulosa* (Milde) C. Chr. The last has been considered by many botanists the same as our Boott's fern, but Christensen puts this as doubtful, and in my opinion they are not the same.

DRYOPTERIS CRISTATA × SPINULOSA (Milde) C. Chr.

Aspidium cristatum × *spinulosum* Milde, Nova Acta Acad. Leop.-Carol. **26**: 533. 1858.

Dryopteris cristata × *spinulosa* C. Chr. Index Filicum 259. 1905.

Of this fern I have collected specimens near Suffern, N. Y., *3927b*, July 23, 1905, and *5273*, October 6, 1907, Ocean Terrace, Staten Island, *3994a*, August 2, 1905, and *5013*, July 15, 1907; Bulls Head, Staten Island, *4380a*, June 10, 1906, and *5053*, July 24, 1907.

This differs from Boott's fern in having glabrous indusia, sori farther from the midvein, in being less deeply cut, having the stipes less chaffy, and the scales a paler brown.

Dryopteris cristata × intermedia nom. nov.

Aspidium Boottii Tuckerm. Hovey's Mag. **9**: 145. 1843.

Aspidium spinulosum Boottii D.C. Eaton in A. Gray, Man. ed. 5, 665. 1867.

Dryopteris Boottii Underw. Our Native Ferns, ed. 4, 117. 1893.

This occurs frequently in our woodland swamps.

The probability that this fern is a hybrid has been often stated and commented upon, and by many the opinion is held that it is a hybrid between *D. cristata* and *D. spinulosa*, as stated above. It differs from that fern in being more deeply cut, usually bipinnate, more chaffy at the base of the stipe, having the scales darker, the indusia and the under side of the blade glandular, and the sori nearer the midvein.

Dryopteris Clintoniana × intermedia hyb. nov.

Rhizome stout, chaffy: stipes 10–40 cm. long, densely chaffy at the base with thin light-brown scales, which have usually a darker center; blades ovate-lanceolate to oblong-lanceolate, 20–75 cm. long, 15–25 cm. wide, acuminate at the apex, slightly narrowed at the base, pinnate-pinnatifid to twice pinnate; pinnae oblong-lanceolate to triangular-lanceolate, acuminate, broadest at the base, the upper pinnatifid, the lower pinnate toward the base

in the fertile fronds; pinnulae 10–15 pairs, linear-oblong to oblong, acute or obtuse, somewhat falcate, serrate or the lower incised, the lobes spinulose-toothed with appressed teeth; sori nearer the midvein than the margin, indusia thin, reniform, glandular, not large.

In general appearance this fern resembles the Clinton fern more than the other, but it differs from that fern in the deeper cutting of its pinnae and in having glandular indusia, which are also smaller. It differs from *D. intermedia* in its more elongate shape, in the greater difference between its sterile and fertile fronds, in being less cut or divided, and in having the sori nearer the midvein. It resembles Boott's fern, *D. cristata* × *intermedia*, more than it does any other. This is to be expected when we consider that they have one parent species in common and the other (*D. cristata* and *D. Clintoniana*) so closely allied that most botanists have heretofore placed one as a variety of the other. It differs from Boott's fern in being usually larger, wider in proportion to the length, being less deeply cut, having the pinnulae more falcate, the teeth more incurved or appressed, and the sori nearer the midvein. In the type locality and near Cornwall, Conn., vigorous plants of this fern were not rare. In the type locality I should call it fairly abundant, as abundant as Boott's fern, which grows in luxuriance in that locality. It was found associated with the alleged parent species in the following localities, except Bulls Head, where I have found only one plant of this fern and no plant of *D. Clintoniana*.

NEW JERSEY: Swamp above Lake Macopin, near Newfoundland, September 3, 1906, *Dowell 4606*, type; July 27, 1907, *5069*.

NEW YORK: Suffern, July 23, 1905, *Dowell 3928*, October 6, 1907, *5269*; Bulls Head, Staten Island, August 3, 1905, *3995*; Richmond, August 17, 1905, *4049*.

CONNECTICUT: Cornwall, July 4 and September 10, 1907, *R. C. Benedict 72* and *267*.

Dryopteris Clintoniana × **Goldiana** nom. nov.

Dryopteris Goldieana celsa Palmer, Proc. Biol. Soc. Wash. **13**: 65. 1899.

Rhizome thick, chaffy: stipes 20–50 cm. long, densely chaffy at the base with thin light-brown scales having a darker center, or

with some thick dark-brown elongated scales; blades pinnate pinnatifid, acuminate, the sterile triangular-ovate to ovate-lanceolate, 20–50 cm. long, 15–25 cm. wide, fertile blades ovate-lanceolate to oblong-lanceolate, narrowed at the base, 40–80 cm. long, 20–35 cm. wide; pinnae deeply incised, sometimes divided at the base, ovate-lanceolate to oblong-lanceolate, acuminate, in some fronds the upper broadest at the base while the lower are narrowed at the base, in other fronds the lower broadest at the base while the middle and upper ones are broadest near the middle; pinnulae or lobes of the pinnae 10–20 pairs, oblong to oblong-linear, obtuse or acutish, falcate, appressed-serrate or those of the lower pinnae slightly incised; sori near the midvein, indusia thin, glabrous.

In general appearance this fern resembles the Clinton fern, with which it has been placed by some, while others have referred it to the Goldie fern. It differs from the former in having some of the thick dark-brown scales characteristic of the latter, and in having some of the pinnae narrowed at the base.

It differs from the Goldie fern in having fewer of the thick dark scales; the fronds usually more narrow, more gradually tapering, and more narrowed at the base; the basal pinnulae longest on a portion of the frond, the upper in some, the lower in others.

NEW YORK: Swamp near South Avenue, Staten Island, October 9, 1904, *Dowell 3558*, type; low woods, Lower Genesee, near Rochester, *W. H. Lennon*, June 16, 1895.

NEW JERSEY: Springdale, near Newton, *Dowell 4929* and *5033*, July 4 and 22, 1907.

VERMONT: Swamp near Willoughby Lake House, August 21, 1896, "ex herb. *E. & C. E. Faxon.*"

NORTH CAROLINA: Chapel Hill, September 1907, *W. C. Coker.*

VIRGINIA: Dismal Swamp, June 8, 1899, *William Palmer 247 i, j*, and *k*, labeled "*D. Goldieana celsa*, paratype." This last was reported as growing on logs, the others grew in the soil.

Dryopteris Goldiana × intermedia hyb. nov.

Fronds 7.5–12 dm. long, about 3 dm. wide: stipes 25–40 cm. long, densely chaffy at the base with thick dark-brown linear-lanceolate scales and thin membranous scales, the latter extending on the rachis; blades 50–75 cm. long, about 30 cm. wide, ovate

to oblong, bipinnate; pinnae oblong to oblong-lanceolate, mostly broadest toward the middle, the lowest unequally ovate-lanceolate, those near the middle of the blade most divided; pinnulae oblong or lanceolate, falcate, acute, large, incised, the lobes spinulose-toothed; sori slightly nearer the midvein than the margin, nearly terminal on the veinlets; indusia thin, glandular, not large, intermediate in cell-structure between those of *D. Goldiana* and *D. intermedia.*

In general appearance this fern looks like a large overgrown *D. intermedia*, but it differs from this in having the thick dark scales characteristic of *D. Goldiana* and the sori nearer the midvein. It differs from the Goldie fern in the cutting of the frond and in having glandular indusia, while it resembles this fern in its shape and size, in the shape of its pinnae and the falcate shape of the pinnulae, and in the character of its scales.

Type specimens are in the herbarium of the New York Botanical Garden, collected by Professor L. M. Underwood, August, 1899, near Jamesville, New York, in a locality abounding in *D. intermedia* and having occasional patches of *D. Goldiana.*

Dryopteris Goldiana × marginalis hyb. nov.

Rhizome short, thick, densely chaffy: fronds erect or ascending, 5–11 dm. tall; stipe 20–35 cm. long, densely chaffy at the base with thick dark-brown linear-lanceolate scales mixed with thin membranous scales, the latter extending on the rachis; blade bipinnate, abruptly acuminate, the sterile triangular-ovate to ovate-lanceolate, 15–50 cm. long, 10–20 cm. wide, pinnate-pinnatifid; the fertile ovate-lanceolate to oblong-lanceolate, 30–75 cm. long, 20–35 cm. wide, bipinnate; pinnae ovate-lanceolate to oblong-lanceolate, long-acuminate, broadest toward the middle; pinnulae oblong to oblong-linear, falcate, acute or obtuse, serrate or incised, decurrent on the rachis, those on the lower side of the basal pinnae sometimes conspicuously elongated; sori about midway between the margin and the midvein, or nearer the margin, indusia firm, glabrous, not large.

In general appearance, as well as in detailed characteristics, this fern is intermediate between its alleged parents. Large fronds suggest *D. Goldiana* in appearance while the smaller look like *D. marginalis*, but all the specimens and the several plants examined showed scales characteristic of both species, their sori are intermediate in position, and the indusia intermediate in character. Its

relationship to the Goldie fern is established by the presence of the unmistakable dark elongated scales, while its relationship to the marginal fern is shown by the character of the indusium and the shape and color of the frond, — the characteristic dark bluish-green upper surface and the glaucous appearance of the under side. It differs from the latter by its larger size, by its thick dark-brown scales, and by the position of the sori away from the margin. It differs from the Goldie fern in having the fertile fronds bipinnate, in the greater difference in color between the two surfaces of the frond, in having thicker indusia and the sori midway between the midvein and margin.

About a score or more plants of this fern were found along the edge of a large swamp west of Springdale, near Newton, New Jersey, on July 4, 1907, *Dowell 4931*, type. On July 22 another plant (*no. 5035*) of this fern was found in a different part of the swamp. The marginal fern is common and the Goldie fern is occasional along the edge of the swamp.

Most of the specimens cited above are in the herbarium of the New York Botanical Garden.

In conclusion I may add that this paper is not intended primarily as a contention or a defense for the theory of hybridity. The principal points on which I base my opinion that these ferns are hybrids, may be summed up briefly as follows: Each fern has characteristics common to two species and cannot be referred to any one previously described species alone, except in the case of Boott's fern, which has been described as a species; they have a tendency to be sterile, the sporangia being largely abortive; they occur only occasonially, and rarely in large numbers in any one locality; they grow in places favorable for the mingling of the gametes; they are found usually associated with the supposed parent species; hybrids among ferns have been experimentally produced, and are known to exist.

PORT RICHMOND, N. Y.

The correlation of flower- and fruit-structure in Carica Papaya

P. J. Wester

The papaya (*Carica Papaya* L.) is a small tree, — dioecious, or rarely bearing perfect flowers. The normal staminate flower is funnel-shaped with a long slender tube, the lobes being shorter than the tube and with ten anthers inserted in the throat of the corolla, the pistil being abortive. The normal pistillate flower is larger than the staminate and has distinct petals and a sessile ovary, which is large, round or angular, and contains numerous ovules. The stigma is sessile and five-rayed, with rays ultimately branched to six or more flattened lobes, and the stigmatic area extending a short distance around upon the dorsal surface (FIG. 1, *a*; for the sake of clearness only one of the five rays is shown).

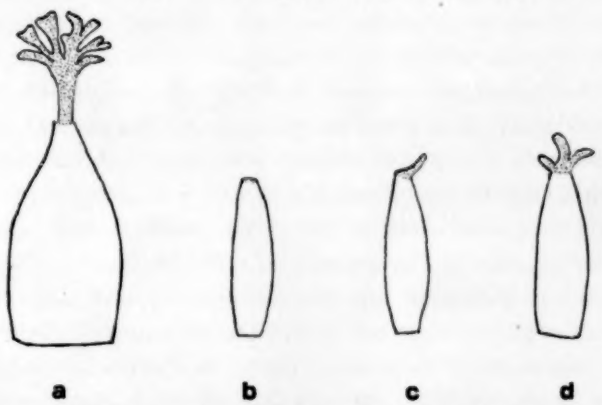

FIG. 1. Pistils of *Carica Papaya* showing different forms of stigma. (Enlarged about 1/5.)

During the summer of 1904 the attention of the writer was called to a rather unusual difference in the shape and size of the individual fruits on a papaya growing in the garden of the Subtropical Laboratory. The plant, being old, ceased to bear in the autumn and died later, but a cutting had fortunately been rooted successfully during the summer, and was planted out in the winter. Recalling the interesting fruits noted on the parent tree,

the development of this plant was watched with great interest. In July, 1905, the first flowers appeared. For several weeks all blossoms were staminate. In August several hermaphrodite flowers opened, which are rather rare in this species. By far the greater number of the flowers were staminate, but as the plant grew larger, quite a number of perfect flowers appeared in the axil of every leaf. On examination it was found that the structure of these flowers varied to a remarkable degree. Three distinct types of flowers were easily recognized: (1) those resembling a pistillate flower more than a staminate, large, tube one-half as long as lobes, anthers inserted in the throat of corolla, ovary large, angular, stigmatic end superior to anthers, ovules numerous, stigma normal; (2) those with the characters of both the staminate and pistillate flowers equally present, tube longer than in the type described above, ovary not so large, one or more of the stigmatic rays abortive, in some instances only a rudimentary ray being present (FIG. 1, *c* and *d*): (3) flowers approaching more closely a staminate flower in structure than either of the two classes mentioned, having the tube and lobes of equal length, ovary small, slender, ovules few, stigma reduced to a stigmatic area at the apex of the ovary (FIG. 1, *b*), inferior to or level with the anthers. It was noted also that the pollen masses were released just before or about when the flowers opened where it was inferior to or on a level with the anthers and in some instances, at least, where this organ was superior to the anthers.

In order to determine whether the development and formation of the fruit might be correlated with the structure of the flower, a series of notes was taken upon a number of flowers all on the same tree. In most instances the bisexual flower-buds were bagged with small paper sacks before they opened, the sack being retained until the flower had faded and the ovary was beginning to develop. Numerous small black ants frequent the flowers of the papaya to get the honey secreted, and to prevent a possible cross-pollination by these insects a broad band of cotton was tied around the trunk of the plant, which prevented their ascent. It may be mentioned here that bees or other large flying insects do not seem to act as fertilizing agents in this species, the pollen evidently being carried by the wind, or, more probably, by small insects, from the stami-

nate flowers to the pistillate. All the male flower-buds on the plant were picked before they opened to prevent a possible conveyance of pollen from them by the wind to the flowers not bagged. Twenty-three flowers were numbered as they opened and the differences in their structure noted. Seven of these were not bagged. Of the flowers that did not set fruit, two had small ovaries with stigma reduced to a stigmatic area at the apex of the ovary, one of these two not being bagged. Five fruits were injured by insects so that they dropped or ripened prematurely and one was cut to give the other fruits more room. The first fruit was picked April 23, 1906, and the last June 26. As they were tested each fruit was weighed then cut through the center longitudinally with a sharp knife and an outline of the fruit and cavity traced on a paper. The dried seed from each fruit was also weighed. That the hermaphrodite flowers do not need external aid in pollination and that they are fertile with their own pollen was fully demonstrated, as in no instance were the flowers hand-pollinated. The chances that the unbagged flowers were fertilized by the wind were also exceedingly slight, as no male plants were growing in the vicinity. The supposition that the characters of the flower might be correlated with the form and size of the fruit was fully borne out and is best illustrated in the accompanying photograph (FIG. 2) of the tracings of six fruits. By referring to the following notes corresponding to the numbers above the outlined fruits it will be seen that where the ovary was small and slender, with rays in the stigma nearly aborted, the fruits grew comparatively small, cylindrical and oblong, almost solid, with exceedingly small seed-cavity containing few seeds, while where the pistil was normal, or nearly so, the fruits grew large, more or less angular, with the apical end distended, and the cavity containing a large number of seeds.

Unfortunately, no fruits matured from flowers where the stigma was rayless, as the fruits dropped, being injured by insects. The following notes all refer to hermaphrodite flowers:

No. 2. October 5, 1905. Flower bagged; tube long; ovary slender; stigma reduced to stigmatic area at apex of ovary with one short ray like FIGURE 1, *c*; mature April 23; weight of fruit 600 grams; seed-cavity small; weight of dried seeds 2 grams. (FIGURE 2, no. 2.)

No. 4. October 7, 1905. Flower not bagged; tube long; ovary slender; stigma reduced to stigmatic area at apex of ovary with short ray like FIGURE 1, *c*; mature April 23; weight of fruit 345 grams; seed-cavity very small, containing few seeds; weight of dried seed one gram. (FIGURE 2, no. 4.)

No. 7. October 10, 1905. Flower bagged; tube long; ovary slender; stigma reduced to stigmatic area at apex of ovary with three short rays, about like FIGURE 1, *d*; fruit mature April 23; weight of fruit 520 grams; seed-cavity small, containing few seeds; weight of dried seed 2 grams. (FIGURE 2, no. 7.)

No. 15. October 17, 1905. Flower bagged; tube short; ovary large and angular; stigma normal like FIGURE 1, *a*; fruit mature May 8; weight of fruit 2115 grams; seeds numerous and more than lining cavity; weight of dry seed 15 grams. (FIGURE 2, no. 15.)

No. 16. October 18, 1905. Flower bagged; tube short; ovary very large and angular; stigma normal like FIGURE 1, *a*; fruit mature May 31; weight of fruit 1620 grams; cavity well filled with seed; weight of dried seed 15 grams. (FIGURE 2, no. 16.)

No. 17. October 18, 1905. Flower bagged; tube short; ovary very large and angular; stigma 4-rayed, otherwise normal; fruit mature June 6; weight of fruit 1920 grams; weight of dried seed 16 grams. (FIGURE 2, no. 17.)

The fruits developed from flowers in which the stigmatic rays were almost entirely abortive contained several undeveloped ovules, and the fruits were smaller than those developed from flowers where the stigmatic area was large. No. 14, flower bagged, was an interesting exception. The flower to this fruit was similar to that of no. 15. On maturity the fruit weighed 580 grams. Of a large number of ovules very few had developed to seed, which, dried, weighed only 0.75 gram. The general outline of the fruit was similar to that of no. 15 and the seed-cavity was proportionately as large. It is possible that the inferior size of this fruit may have been due to imperfect pollination, so many ovules having failed to develop, and it may partly be the cause of the small size of nos. 2, 4, and 7 also, although it is believed that a difference in the structure of the pistil is the greatest factor in determin-

ing the growth and development of the fruits, in view of the fact that the number of ovules is small and the wall of the ovary thick where the stigma is small, while the number of ovules is great and the cavity large and the ovary wall thin where the stigmatic area is large.

The seed from the different fruits was saved and planted in 1906. A large number of these seedlings perished, unfortunately, in the hurricane in October and the severe freeze of December the same year. Of those that survived a very much larger number proved to be hermaphrodite plants than is the case with seedlings grown from fruits commonly found in the market.

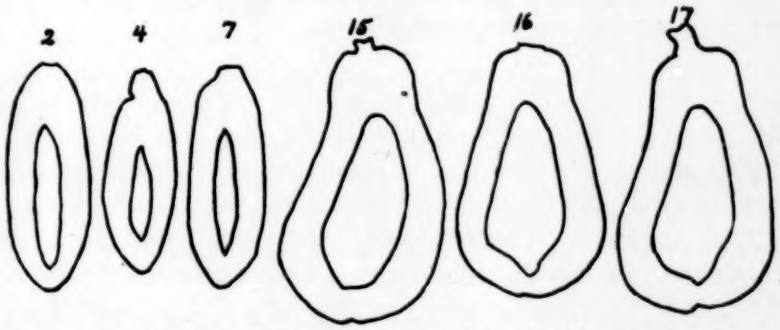

FIG. 2. Outlines of fruits of *Carica Papaya*. (About 1/6 natural size.)

Since the above notes were made, the flowers on a large number of papaya plants have been examined. Few hermaphrodite plants are found, but, in all trees bearing bisexual flowers that have been noted, the variation in the structure of the flowers, as stated above, has been recorded.

The papaya, as commonly propagated at present, has too large a percentage of worthless seedlings to be commercially profitable. Good material for cuttings is, from the nature of the tree, difficult to obtain and is so difficult to root without bottom heat — seldom or never used in rooting plants in the tropics or subtropics — that this mode of propagating a good variety does not commend itself. It has been demonstrated at the Subtropical Laboratory that inarching can be done, but this is necessarily a slow and cumbersome method of propagation.

An attempt to originate a variety of papaya by inbreeding

would probably be more successful if the flowers were hand-pollinated with their own pollen than if pollination were accomplished with pollen from flowers differing in structure. It seems quite probable that in a batch of seedlings grown from an individual fruit with small seed-cavity and few seeds — the flowers of course being bisexual — some seedlings would have a greater percentage of flowers that would develop this type of fruit, which would be preferable commercially to fruits with large cavities containing numerous seeds. It is probable that by inbreeding and rigid selection for several generations a variety of papaya bearing all its fruits of this type might be originated, which, the flowers being self-pollinated, would reproduce itself true to the variety.

SUBTROPICAL LABORATORY, MIAMI, FLORIDA.

Sorosporium Ellisii Winter, a composite species

H. S. Jackson

In October, 1907, the writer collected a *Sorosporium* on *Aristida dichotoma* in the vicinity of Newark, Delaware, and found on examination that it agreed with specimens on the same host referred to *Sorosporium Ellisii* Winter. An examination of the specimens in Ellis & Ev. N. A. Fungi, led me to believe that *Sorosporium Ellisii* as described by Winter was a composite species.

Winter based his *Sorosporium Ellisii* on two collections sent him by Mr. J. B. Ellis. One of these collections was made by Mr. Ellis on *Andropogon virginicus* at Newfield, N. J., Oct., 1880; the other on *Aristida dichotoma* by Mr. Wm. Trimble in Chester Co., Pa., Sept., 1880, and communicated to Mr. Ellis by Dr. Martin. Recently I had the opportunity of examining material in the Ellis and other collections in the herbarium of the New York Botanical Garden, and became convinced that the form on *Andropogon* is specifically distinct from the one on *Aristida*.

In separating these two forms into species, the question arises as to which shall be quoted as the type of *Sorosporium Ellisii*. The original description appeared simultaneously in Hedwigia **22**: 2. Ja 1883, and in Bull. Torrey Club **10**: 7. Ja 1883. In Hedwigia, *Aristida* is the first host mentioned, while in the Bulletin of the Torrey Botanical Club, *Andropogon* is mentioned first. It is seen that as far as the original description is concerned neither specimen can be said to have priority. As to the date of collection, the form on *Aristida* was collected in September, 1880, while that on *Andropogon* was taken in October, 1880, as is shown by the data on the envelopes in the Ellis collection. This fact might lead some mycologists to give precedence to the form on *Aristida*. However, Winter named his fungus in honor of Ellis, and it seems proper to consider the specimen collected by Ellis as the type.

Sorosporium Ellisii Winter, therefore, should refer to the form on *Andropogon*, which has the following distribution:*

On Poaceae:

Andropogon virginicus L. New Jersey.

Andropogon scoparius Michx. Connecticut, Illinois, Kansas.

TYPE LOCALITY: Newfield, N. J., on *Andropogon virginicus* L.

EXSICCATI: Seym. & Earle, Econ. Fungi *C 38;* Ellis & Ev. N. A. Fungi *1099*.

The two specimens of the original collections on *Andropogon* and *Aristida* are marked (probably by Ellis) *Sorosporium Ellisii* Winter f. *Andropogonis* and f. *Aristidae* respectively. The name *Sorosporium Aristidae* is, however, untenable.† The following name with description is proposed for the form on *Aristida*.

Sorosporium confusum sp. nov.

Sori in the ovaries, enclosed by the enveloping glumes, elongated, tapering above, 3 mm. in length, provided with an inconspicuous membrane which ruptures irregularly: spore-balls irregular, subglobose or elongated, 30–100 μ in length, at first firm, but easily separating into spores: spores subspherical or polyhedral, frequently flattened and so appearing elongated or subcircular in section, according to view, mostly 12–14 μ, occasionally only 10 μ and reaching 15.5 μ in length; wall verruculose.

On Poaceae:

Aristida dichotoma Michx. Pennsylvania, *Trimble;* Ohio; Delaware, *Jackson.*

Aristida purpurascens Poir. (?) Alabama, *Underwood.*

TYPE LOCALITY: Newark, Delaware, on *Aristida dichotoma.*

DISTRIBUTION: Delaware to Ohio and Alabama.

EXSICCATI: Ellis & Ev. N. Am. Fungi *1494*.

The two species are easily separated by the character of the sorus. In *S. Ellisii* the whole infloresence is affected, in *S. confusum* only the ovaries. The spores in the latter are somewhat smaller than in the former.

The Delaware specimen is selected as the type because it is the best material we have seen. The specimens in Ellis & Ev. N. A. Fungi *1494* are mostly barren. This fact, together with

* Taken from Clinton, N. A. Flora 7: 39. 1906.

† See Saccardo, Sylloge Fungorum 13: 123; *Sorosporium Aristidae* Neg. (unpublished ?).

the small number of collections made, probably accounts for this species having been so long overlooked. The type specimen has been deposited in the herbarium of the New York Botanical Garden. The Alabama material differs from the type in its slightly darker spores. The Ohio material has not been seen, but is here included on the authority of Clinton (*l. c.*).

The writer here acknowledges the kindness of the officials of the New York Botanical Garden in giving him unrestricted use of their library and herbarium.

AGRICULTURAL EXPERIMENT STATION,
NEWARK, DELAWARE.

INDEX TO AMERICAN BOTANICAL LITERATURE
(1908)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions their kindness will be appreciated.

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Britton, E. G. The collections of mosses and hepatics. Jour. N. Y. Bot. Gard. **9**: 21–23. F 1908.

Britton, N. L. Professor Underwood's relation to the work of the New York Botanical Garden. Bull. Torrey Club **35**: 39, 40. 29 F 1908.

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